Southeast Asian Cannon Making in Negara Brunei Darussalam

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For my cousins,

Azim and Karni

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SUMMARY

This thesis uses archaeological and historical sources to elucidate the manufacturing techniques used to make so-called Southeast Asian cannon. These guns form a unique artefact group and are distributed across the Southeast Asian region. Although limited research on these cannon has been undertaken, the dearth of relevant historical records has left one aspect about them unresolved: how the guns were made.

Some 24 elongated clay cylinders, presumably bore clays, and other metalworking artefacts believed used for cannon making were found in two deposits in Brunei, one in 1994 at Kota Batu and the second in 1999 on Terindak Island. This research examines these artefacts, along with seven cannon from the Brunei Museum and traditional gun casting as still practiced in Brunei to provide some insight into how Southeast Asian cannon were cast.

Southeast Asian cannon played a significant role in the history and culture of Brunei, and their manufacture was an important technology for the country. The documentation of these cannon and study of the metallurgical and casting technologies used to make them will enhance their value as museum pieces and provide insights to their history and that of the people who manufactured them. It is hoped as well that this thesis will encourage and aid other researchers, curators or archaeologists who encounter similar guns to study them thoroughly.

DECLARATION OF CANDIDATE

I certify that this thesis does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

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CHAPTER 1
INTRODUCTION

So-called 'Southeast Asian cannon' are unique artillery artefacts that are widely distributed across the Southeast Asia region. These cannon usually are identified as a type of swivel gun, are heavily decorated and typically have a tubular cascabel into which a tiller is inserted for handling. The type is known by different names, such as *lentaka* in the southern Philippines, *lela* in Malaysia and *bedil* in Brunei. In spite of this differing terminology, most of these guns are similar enough to be grouped under the common appellative 'Southeast Asian cannon', as is typical especially in European scholarship. Some scholars refer to the type as "amphibious", since the guns can be used as easily on land or at sea, mounted on terrestrial fortifications or fitted on ships' rails (Charney 2004:49–50; Jateff 2001:1; Shariffuddin 1969:89–91).

To date, little research has been done on Southeast Asian cannon and many particular aspects of these guns remain unstudied (Green 2006:9; Jateff 2011:8). This probably is due to their diminutive firepower and elaborate decoration in comparison to their European counterparts. In general, the weapons are treated as objects of display rather than subjects of research. Often, they are exhibited in museums with no accompanying background or interpretive information and with no research being undertaken.

This thesis attempts to address this situation by recording and assessing a selection of these cannon in order to identify the method of their manufacture. Data from three sources—ethnographic, archaeological and historical—are collected in order to create a comprehensive dataset and optimize the available evidence.

Aims

The overriding aim of this thesis is to determine how Southeast Asian cannon

were made; what techniques did local gun founders in Southeast Asia use historically and what similarities did these have with manufacturing methods employed today. These questions are addressed through the following lines of inquiry, which are applied in particular to seven example cannon from the Brunei Museum:

1. distinguishing local manufacturing traditions and areas of possible foreign influence related to cannon in Brunei and their design, decoration (motifs) and casting. This inquiry will include examination of the historical context for the development of cannon in Brunei;
2. examination of related factors such as gunpowder, cannon use and even local beliefs and the influences these had on cannon manufacture, including the possibility of standardization in design and production; and
3. determining to what degree modern-day gun-founding practices are connected to historical methods and reflected in historical accounts and the archaeological artefacts. This particular research attempts to identify the evidence (or type thereof) that can indicate the differences and/or similarities between past and present techniques for making these cannon and their possible implications.

This thesis will lay out a step-by-step account of the cannon-making process and compare it to relevant historical documentation, recent ethnographic studies, and associated archaeological artefacts from early Southeast Asia.

Background Information

To date, no gun-casting records have been found in Brunei, and perhaps none exist. Skills and knowledge pertaining to the industry were passed down from one generation to the next through oral tradition, and technological know-how circulated only within the respective guilds (Harrisson 1969:110; Lim and Shariffuddin

1976:142; Owen 1910:10). In this way, the guilds protected their technological and trade knowledge and maintained their competitive edge. Consequently, however, as practice of the art gradually disappeared, succumbing to modernization, much of its expertise and knowledge was lost.

However, seven gun foundries in Kampong Ayer were rediscovered in 1975 (Lim and Shariffuddin 1976:141). The event sparked renewed interest in traditional cannon making and prompted the Brunei Government to establish the Brunei Arts and Handicraft Training Centre (BAHTC) in Kota Batu in order to preserve this and other traditional craftworks.

In 1994 and 1999, archaeologists excavated two sites—in Kota Batu and on Pulau Terindak (Terindak Island), respectively—that yielded evidence of gun founding (Bulat 2006:5–6) (Figures 1 and 2). Kota Batu is the site of a former fortress and residence of the sultans from the fourteenth to sixteenth centuries (Pengiran Haji Osman 1992:29–30). It is situated at the mouth of the Brunei River overlooking the present capital, Bandar Seri Begawan. Nearby is Terindak Island, a man-made island adjacent to the fort site thought to have been created between the twelfth and thirteenth centuries. The archaeological finds from these sites included 24 presumed clay bore moulds, several crucibles and raw materials believed used in the manufacturing of cannon.

In addition to these artefacts, the Brunei Museum lists 721 ordnances in its most recent catalogue (Bulat 2006:1). This large number reflects the crucial role cannon played in Brunei history and culture. These cannon are used still today, although in a more symbolic role, especially in royal ceremonies.

Although often perceived as being of one common type, Southeast Asian cannon in fact comprise a variety of different gun types. The five main categories of Brunei

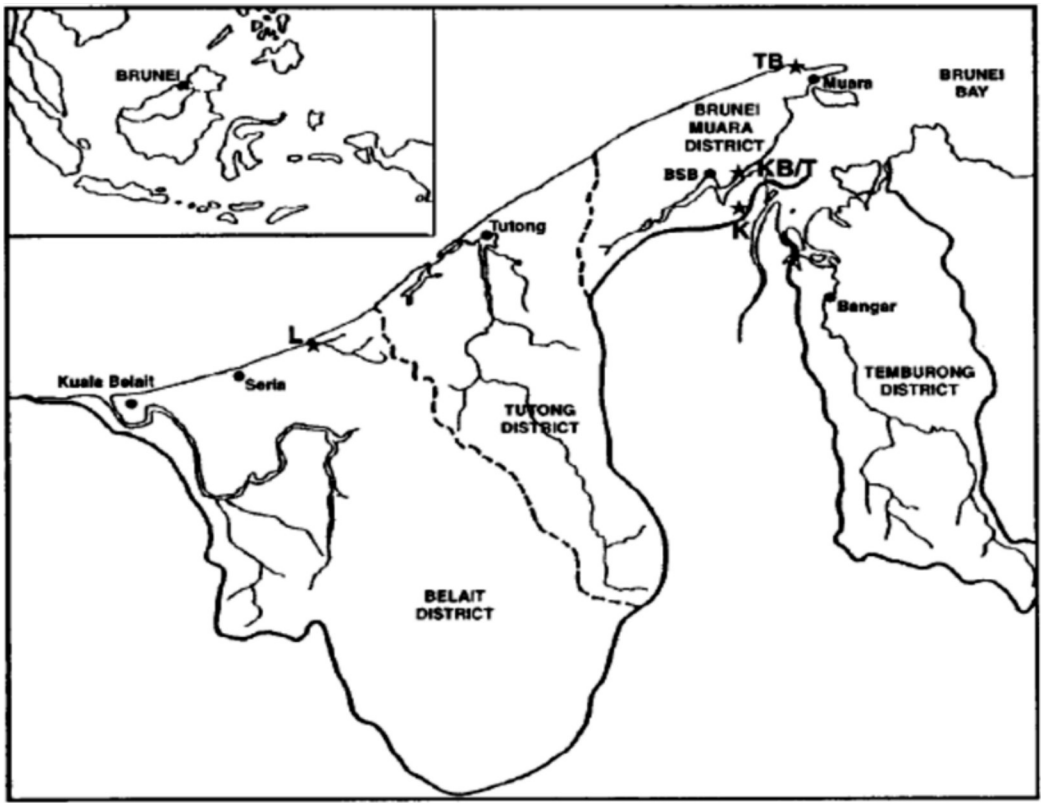


Figure 1. Map of Brunei Darussalam showing Kota Batu (KB/T) and other archaeological sites, including Tanjong Batu (TB), Lumut River (L) and Kupang (K) (from Omar 1994:3).

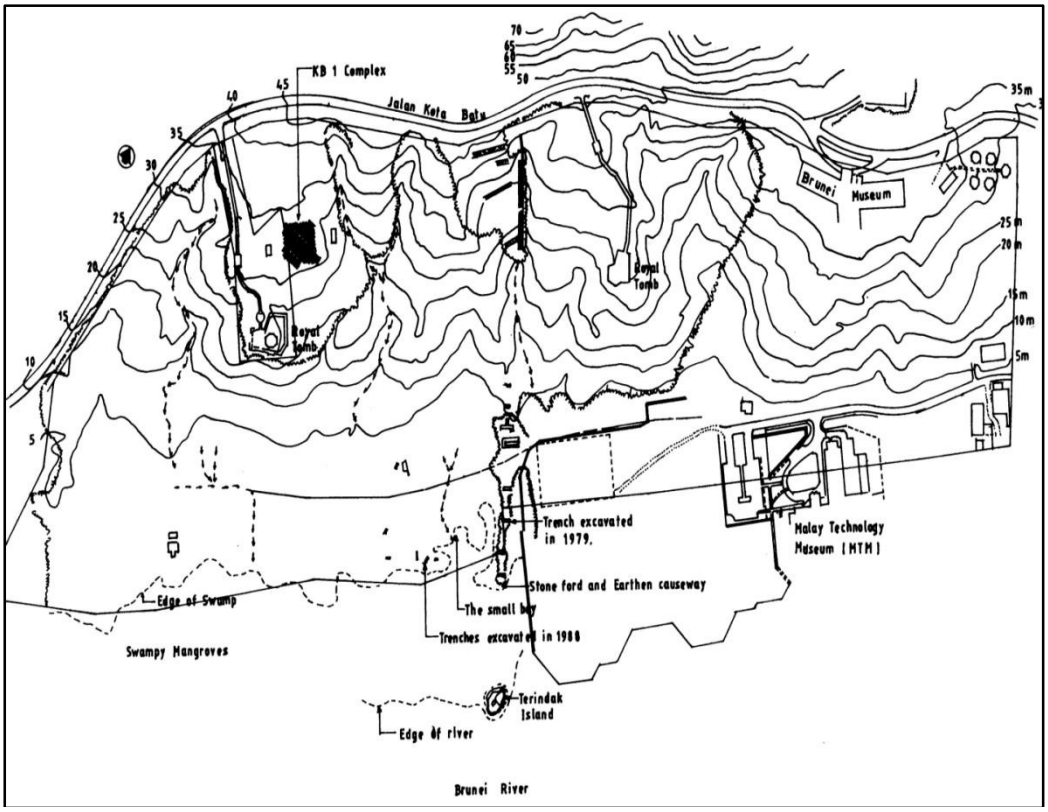


Figure 2. Location of Kota Batu in relation to Terindak Island (from Pengiran Haji Osman 1992:33).

Southeast Asian cannon, as coined by Shariffuddin (1969:76–79), are:

- *Bedil Gargabus* – cannon with a large round mouth, or muzzle, shaped like a trumpet. The name is thought to derive from the English word *blunderbuss*.
- *Bedil Naga* – swivel cannon shaped like a dragon or other reptile.
- *Bedil Buloh* – smooth-barrelled swivel cannon with little or no decoration.
- *Bedil Lapis* – cannon distinguished by their multi-colourisation, believed caused by the mixtures of different minerals used in their manufacture (although this has yet to be confirmed by chemical analysis). In all other ways, the cannon of this type would belong to one of the aforementioned categories.
- *Meriam* – heavily-built cannon that usually have a large and rounded cascable. The type is not considered typical of Brunei cannon.

Study and comparison of the archaeological materials related to gun founding and a sampling of actual cannon in the Brunei Museum collection, along with observations of traditional gun founding practiced at BAHTC, provide new insights into how Southeast Asian cannons were made.

CHAPTER 2
THE DEVELOPMENT OF CANNON IN BRUNEI

Historical Background

Cannons have been mention in Brunei history rather frequent (Curriculum Development Department [CDD] 2006; Harrison 1969; Saunders 2002; Shariffuddin 1969; Teoh 2005). Bruneian cannon usage can be traced back to as early as the late fifteenth century (Shariffuddin 1969:73–74), during the reign of Sultan Bolkiah (1485–1524)[1] who conquered Luzon and Manila in the Philippines using his personal cannon called *Si-Gantar Alam*. Thereafter, subsequent sultans also made use of artillery. For example, Sultan Muhyiddin (1673–1690) presented tributary cannon called *Si-Mambang* and *Raja Andai* to Sulu to seal an alliance in his civil war against his predecessor, Sultan Abdul Hakkul Mubin (1661–1673). In a last act of defiance before his defeat, Sultan Abdul Hakkul Mubin loaded the original Brunei royal crown and other regalia into his personal cannon and shot them out across the sea.

Although the possibility exists that such histories have been embellished, Europeans recorded the existence of cannon in Brunei in the sixteenth century when they first arrived in the Indies. In 1521, the Portuguese explorer Magellan, in service of King Charles I of Spain, arrived in Brunei, where his assistant, Antonio Pigafetta, noted the presence of cannon: "In front of the Sultan's Palace, there was a rampart, constructed of large bricks with barbicans in the manner of a fortress on which are mounted fifty-six brass and six iron cannon" (Pigafetta 1969:101).

So, how did cannon technology come to Brunei? This perplexing question is comparable to determining which country first invented firearms. However, what is certain is that the presence of cannon in Brunei can be ascribed primarily to the

[1] See Appendix 1 for Brunei's Sultan Genealogy

country's geographical location. For centuries, Brunei was an entrepôt and transit point for foreign traders coming and going according to the seasonal monsoon winds, which blow out of the north-east from December to March and the south-west from June to September (Figure 3) (Teoh 2005:4).

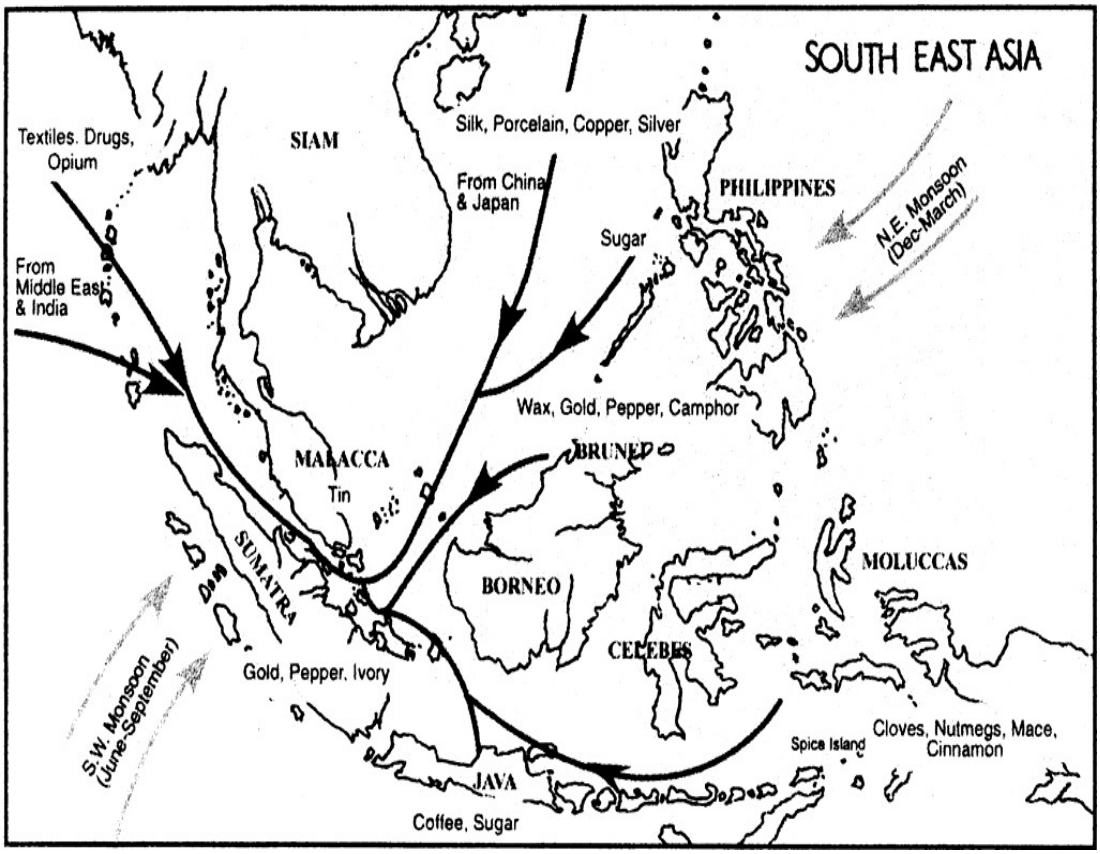


Figure 3. Early trade patterns in Southeast Asia (from Teoh 2004:4).

Cannon Development in Brunei Darussalam

One aspect of cannon in Southeast Asia that has received much attention is the origins and conveyance of these weapons and associated gun-making technology to the region, although much information is still rudimentary and in need of explication (Andaya 1999; Harrison 1969; Laichen 2003; Reid 1993). This chapter will compile and summarise the various opinions on the transfer of firearms to Southeast Asia and then apply these views to the situation in Brunei in order to assess which one best fits the historical and archaeological evidence.

Before delving into the subject of firearms specifically, a brief note on the state of metalworking in Brunei prior to the introduction of cannon is warranted. Historical records suggest that Brunei already was making metal household items and musical instruments as early as the ninth century (Saunders 2002:27). The Chinese record book *Chu Fan Chi*, written by Chinese maritime trade inspector Chau Ju Kua (1970:156), who visited Brunei in 1225, mentions that Brunei was equipped with metal swords and armour. Thus, with metalworking in Brunei already centuries old, it is safe to assume that local craftsmen could readily have adapted their skills and learned cannon making once it arrived to their shores.

It is widely accepted that gunpowder and then firearms were invented in China, but the situation for cannon specifically is less certain (Chase 2003:1; Ling 1947:160; Mauncy 1965:3). The use of rudimentary cannon in China can be dated by literary evidence to as early as the late twelfth century. However, evidence for cannon in the archaeological record appears no earlier than the first half of the thirteenth century (Goodrich and Chia-sheng 1946:123; Ling 1947:160; Needham 1986:277). Most scholars believe that gunpowder weaponry spread across Asia to Europe from China with Mongol expansion in the thirteenth century (Laichen 2003:497; Reid 1993:219). Mongolian conquests included lands in India, the Middle East, Eastern Europe and even parts of Southeast Asia. Brunei itself was under threat of invasion by Mongol forces, although these circumstances still need to be confirmed by research (Saunders 2002:26–28). Undoubtedly, some of the conquered nations would have obtained some of these weapons or possibly even copied them. It is, however, still under debate whether cannon were actually used during the invasion, as mentioned by Sun Laichen (2003:497–498), although cannon certainly could have evolved from the gunpowder weaponry in use at the time.

Cannon were known in Southeast Asia by the early fourteenth century. This most likely was due to the Mongols and the region's continuous interaction with China (Andaya 1992:39). Mainland Southeast Asia (Thailand and Vietnam) is recorded as having native cannon foundries by the early fourteenth century (Andaya 1999:37; Laichen 2003:504). Subsequent local development must have been significant, as the Chinese themselves learned new techniques of casting cannon from Vietnam, although what these techniques were is not known (Ling 1947:175). Elsewhere in the region, the Javanese too were becoming well-versed in making and using cannon after the Mongol invasion of Java in 1293 (Reid 1993:219).

In the Middle East, after the introduction of gunpowder and firearms, Arabs and Turks became adept at making and using cannon, bombs and muskets alike (Andaya 1992:36). The effectiveness of this weaponry was demonstrated by the Ottomans in 1453 against the defensive walls of Constantinople, during their siege and eventual conquest of the great city (Harrisson 1969:101; Mauncy 1965:4). India had cannon as early as 1421, as used in Gujerat in the battle of Malwa (Cipolla 1965:93–106). However, their cannon were not made locally, but were acquired via China and/or the Arab world. According to Richard Whiteway (1969:37), gun casting was new to the subcontinent, and the earliest true Indian gun casting did not occur until 1505, under the instruction of two Milanese cannon founders, Joao Maria and Piero Antonio.

In 1511, when the Portuguese captured Malacca (Malaysia), they found some 2,000–3,000 cannon in the vicinity (Reid 1993:221). These guns are believed to have been mostly foreign made, although supplemented by weapons produced in local Chinese and Muslim gun foundries (Andaya 1999:37).

If we now examine the history of Brunei in the context of firearms development

and diffusion from China to Southeast Asia, India and the Middle East, some correlations can be made. Brunei enjoyed good relations with China in the fifteenth century, when it was a Chinese protectorate. This is well demonstrated by the close ties between the Bruneian and Chinese royal families:

> Alak Betatar [Sultan Muhammad Shah], the Brunei Ruler who received investiture from the Emperor of China, Maharaja Ka[r]na [Sultan Majid Hassan] in 1408, the Brunei Ruler who married a Chinese lady of rank, probably Hsia-Wang (Sura Wangsa) in 1413 and the anonymous ruler who embraced Islam as Sultan Muhammad in 1514–1515 [Nicholl 1990:21].

In addition to the political relationship, Brunei also was a trading partner of China as early as the seventh century (Saunders 2002:24). With such ties, it is possible that the Chinese brought cannon technology to Brunei directly. Examples of this are seven fifteenth-century hand-gonnes recovered from the Brunei Shipwreck (L'Hour and Gawronski 2001:151–158).[2]

Mainland Southeast Asia (the Indochina region and Malay Peninsula) could also have been the transit point for cannon coming to Brunei. Although historical information regarding Brunei and the Southeast Asian mainland is rather scarce, trade connections are evident based on archaeological findings of Siamese and Cham ceramics throughout Brunei. Harrisson (1969:104) believes that Thais, besides trading with Brunei and teaching the people pottery-making, also introduced cannon founding. A similar postulate regarding Vietnam is no less plausible.

Cannon technology may well have come from Java in a much more direct and conspicuous route. During the reign of Sultan Bolikah (1485–1524), 40 Javanese

[2] The dating is based on pottery motifs. Two of the hand-gonnes are on display in the Brunei Maritime Museum, while the other five still are undergoing conservation in France (Matzin bin Haji Yahya, personal communication 2012).

craftsmen were hired to teach metal casting in Brunei (Bulat 2006:6; Pengiran Haji Osman 2007:45). Although there are no specifics on whether this included cannon founding, some local scholars believe that it must have, since it should be no mere coincidence that Bolikah was the first sultan to use cannon.

When considering possible technological transfer from the Middle East, the spread of Islam to Southeast Asia and its influence on Brunei likely is more significant than trade relations between the two regions. A key player in this regard is Sharif Ali, an Arab who became the third Sultan of Brunei, reigning from 1426–1432. He gained the throne after marrying Puteri Ratna Kesuma, the daughter of second Sultan, Sultan Ahmad (1408–1426). The Arab sultan's two most recognised legacies are converting Brunei to Islam and improving the region's defences. The latter he accomplished by employing foreigners, especially specialists from China and Arab territories (Pengiran Haji Osman 2007:51). Additionally, Turkish and other Muslim gun founders commonly travelled and established themselves in newly converted regions, such as in Malacca and parts of India, and could well have done so in Brunei.

Malacca and India also offer possible paths for the transmission of cannon and founding technology to Brunei. There was an established relationship between Malacca and Brunei based on trade and royal intermarriage (Saunders 2002:27). Even after Malacca fell to the Portuguese, the two regions maintained continuous trade (Jorge de Albuquerque, as cited in Nicholl 2007:6). In light of this contact and the number of cannon seized by the Portuguese upon capturing Malacca, it is easy to envision some guns making their way to Brunei, through either trade or gifting.

Some have speculated that the Malacca cannon were made in India and acquired through more indirect means, with some of these then being sent to Brunei

(Robertson 1973:104). Other scholars have tried to make a claim for the introduction of cannon to Southeast Asia by the Portuguese at Malacca. However, since cannon are known to predate the Portuguese arrival, and on the value of Pigafetta's record, this last hypothesis can be discarded (Bulat 2006:6; Shariffuddin 1969:74–75).

The evidence presented demonstrates some of the many viable theories of how cannon first came to Brunei. Each of the views expressed has merit, even if some perhaps appear more valid than others. And even though the Portuguese cannot be credited with introducing cannon into Southeast Asia and Brunei, European influence on gun making and usage in the region was no less significant.

European Influence

Europeans are known to have had superior cannon when they arrived in Asia, a fact that helped the Portuguese secure Malacca and parts of India (Andaya 1999:36–37). It would make sense then that Southeast Asian rulers sought out European expertise for their cannon technology.

In the case of Brunei, not much is known about the direct exchange of armaments with Europeans in the sixteenth century. The Portuguese were the first Europeans to visit Brunei, arriving in 1504 (Ludovico Varthema, as cited in Nicholl 2007:3). However, no Portuguese records of their time in Brunei mention cannon. The possibility exists that they introduced cannon to the Bruneians before the arrival of Magellan's expedition. By the time Malacca fell to the Portugal, Brunei had established good relations with the Portuguese (Jorge de Alburquerque as cited in Nicholl 2007:22–23), who set up a trading post in the country by at least 1526 (Stearn 1997:18–22).

In 1578, the so-called Castille War broke out between Brunei and Spain. The conflict arose after Spain wrested control of the Philippines from Brunei, and was

fuelled by the aspirations of Islam and Christianity (Brown 1974:180–185). In brief, Spanish forces overwhelmed Bruneian opposition and occupied Brunei in April of 1578. Alonso Beltran (as cited in Nicholl 2007:45–46), a Spanish notary, recorded the existence of Portuguese cannons in city. He mentions that the Portuguese were supplying Brunei with ordnance as early as 1523. A similar situation can be found in 1514, when the Portuguese supplied and even taught gun founding to the Persians in their fight against the Turks (Cipolla 1965:110–111).

When the Spanish left Brunei in 1579, the country began to rebuild itself. After witnessing the superiority and capabilities of the Spanish fleet, Sultan Muhammad Hassan (1582–1597) set out to improve his defences and military capacity, and to this end employed a renegade Spaniard to make plans for fortifications, weapons and gunpowder production (Gaspar of Ayala, as cited in Nicholl 2007:92). From these two historical accounts, it is evident that the cannon of Brunei were likely influenced by both the Spanish and Portuguese.

Dating Issues

None of the cannon in Brunei, or, for that matter, elsewhere in Borneo, have been dated scientifically. At present, Bruneian Southeast Asian cannon are believed to date no earlier than the eighteenth century, although there is no concrete evidence to confirm such claims (Spenser 1852:298; Woolley 1948:36).

In the case of Brunei, use of these cannon is linked to a much more recent event—namely, the Second World War, when the cannon were used in the attempt to fend off Japan forces (Harrison 1969:97–99). This would suggest that some of the guns in the Brunei Museum collection could possibly have been made during that time. Once Brunei was occupied, the new Japanese overlords outlawed ownership of weapons of any sort. Some cannon were dumped into the Brunei River, especially by

the residents of Bandar Seri Begawan and Kampong Ayer (Kipli Bulat, personal communication 2012). In addition, many cannon were melted down by both sides to provide raw metal for the war efforts.

Of course, this rather recent usage in no way discredits the historical significance of these cannon, nor their status as artefacts. However, in light of the absence of firm dating, this thesis will start with the assumption that the cannon are later in date—eighteenth to twentieth century—rather than earlier.

CHAPTER 3
PREVIOUS STUDIES

As stated in early, the cannon in the Brunei Museum have served as objects for display, and have not been subjected to study. Some of the cannon are exhibited without even basic data (date, provenance, size, etc.), let alone any interpretive information. This situation is not solely a Bruneian problem, but can be found in other museums around the world that have Southeast Asian canon. One example is the Museu Militar de Lisboa, which houses six Southeast Asian cannon. Little was known about these guns until Pierre Yves-Manguin studied them in the mid-1970s. Even then, though, his published article offered little more than a general description of the cannon (Manguin 1976:238–239).

For the most part, published studies about these cannon tend to be general in scope, typically touching upon their history, importance and cultural ties to particular countries without examining in detail individual weapons. One example is the article by Shariffuddin (1969), which is a thematic study of the Southeast Asian cannon of Brunei that looks at their typology, uses and importance to the country. Another similar article by Othman Mohammad Yatim and Mohammad Zamberi Abdul Malek (1994), titled "Meriam: Dalam Sejarah dan Kebudayaan Melayu Nusantara", delves into similar subjects about these cannon, but in a Malaysian context.

The most recent studies concerning cannon in the Brunei Museum focused on the typology and categorization of individual guns. The original typology established by Shariffuddin in 1969 was replaced by the Museum in 2006 due to provenance questions about some cannon and whether they are "Bruneian" in origin (Bulat 2006:4–5). The current (new) criteria used to classify the cannon is their overall length, by which they are assigned to one of the following categories:

1. Cannon up to 30 cm long
2. Cannon 31–60 cm
3. Cannon 61–90 cm
4. Cannon 91–150 cm
5. Cannon longer than 150 cm

This approach to classification is too general to be of much use, other than for general sorting purposes. It provides no insight into provenance, use or meaning. Nor does it address the distinct variations found in shape and design, for example, the *bedil naga*, *gargabus* and *meriam* guns. This issue of classification will be discussed further, and an alternative method proposed, in the following chapter.

Although this thesis studies gun founding of Southeast Asian cannon, principally through example cannon in Brunei, it is not the first study concerning these guns. Sydney Wignall published an article in 1973 titled "The Crown Piece and its Relationship to the Development of 16/17th Century Cast Bronze Ordnance". As its title indicates, the article deals in particular with the crown piece in the broader context of European gun founding. Wignall (1973:88–91) describes the crown piece as a metal hoop with four to eight prong bars for holding the cannon bore mould in place during casting (Figure 4). Two of the guns identified by Wignall as having been made using such crown pieces are Southeast Asian cannon. The fact that at least some Southeast Asian cannon were manufactured using this technique indicates that some gun founders in the region had knowledge of European methods.

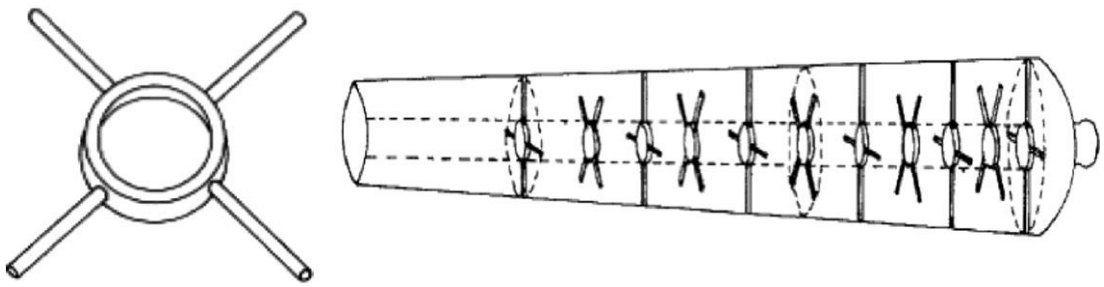


Figure 4. Illustrations of the crown piece and its application (from Wignall 1973:88 and 91).

Jeremy Green's 2006 article, "*The Carronade Island Guns and Southeast Asian Gun Founding*", examines two Southeast Asian cannon found on an unnamed island near Napier Broome Bay in Australia. With the use of x-ray scans and chemical analyses, Green (2006:2−10) was able to determine that the cannon had been fired, detect flaws in the guns' casting, and identify where modifications had been made. Another intriguing discovery he made was the use of chaplets in the founding process. Chaplets are metal bars used in similar manner as crown pieces, to hold the bore mould in place during casting. While both articles discuss certain details of these cannon and particular devices used in their making, neither addresses specifically the type of casting method employed.

In 2011, a preliminary assessment was made of an unusual gun dubbed the South Australian Maritime Museum Cannon (SAMM Cannon). Although still under investigation, it is believed to be an adaptation of a European-type swivel gun of Indonesian origin (Jateff 2011:7). Chemical analyses were inconclusive, but suggest that the cannon may have come from a marine environment. No detail was available on the cannon's metallurgical composition, but additional analyses are planned. Various interpretations were offered based on visual examination of the weapon, in particular concerning the arrangement of its constituent parts. One possible modification suggested is that the gun barrel came from a derelict cannon that was trimmed and fitted with cascabel and trunnions in a rebuild; the forward placement of the latter designed to balance the unusually heavy barrel (Jateff 2011:8). Although only a preliminary report, Jateff (2011:8) notes that further studies into Southeast Asian gun founding are needed to understand these unique artillery pieces.

The only historical account of gun founding in Southeast Asia known to this author is by William Marsden. In his 1811 book *History of Sumatra*, he mentions

that:

> They [the cannon] are wrought by rolling a flatted bar of iron of proportionate dimensions spirally round a circular rod, and beating it till the parts of the former unite; which method seems preferable in point of strength to that of folding and soldering the bar longitudinally. The art of boring may well be supposed unknown to these people [Marsden 1811].

Thus, Marsden's account presents us with one possible method by which gun barrels were wrought in Southeast Asia. The method he describes would seem to preclude use of the chaplets and crown pieces mentioned by Green (2006) and Wignall (1973), respectively. Of course, Marsden's report does not provide every detail of the method, nor does it rule out that other methods were used concurrently in Southeast Asia.

It is surprising that the Brunei Museum has conducted no studies on gun founding, despite the fact that the traditional craft is still practiced in the country (by the BAHTC) and its product is so interwoven into Bruneian history. The one exception is a 1976 study, "Brunei Brass: The Traditional Method of Casting", co-authored by Shariffuddin and published in the *Brunei Museum Journal* (*BMJ*). Remarkably, however, cannon were not included in the study.

In another *BMJ* article, "Brunei cannon: their role in Southeast Asia (1400–1900 A.D.)", Harrisson (1969) attempts to determine the possible originator of Brunei's cannon based on trade and contact and the existence of cannon elsewhere in Southeast Asia. He concludes that trying to pinpoint the origin of cannon is, at best, a subjective undertaking. In spite of this assertion, he does attempt to develop an objective and quantifiable means of identifying Brunei-made Southeast Asian

cannon using the quotient (as percentage) of a gun's calibre to its overall length, rounded to the nearest whole percent (Harrisson 1969:110). For example, a cannon with bore calibre (H) of 4.2 cm and overall length (E) of 113 cm would have a Harrisson value of 4 percent (4.2 cm ÷ 113 cm × 100 = 3.72%, which is rounded up to 4%).[3]

Table 1. Harrisson ratios for a selection of Brunei cannon (taken from Harrisson 1969:110–111; Sharriffuddin 1969:93)

Cannon	Bore Diameter H (cm)	Overall Length E (cm)	Harrisson Ratio H/E (%)
Bedil Buloh – type	3.4	120.1	2.8%
Bedil Buloh – larger	4.2	146.0	2.9%
Bedil Buloh – smaller	3.1	109.3	2.8%
Bedil Lapis – type	3.7	117.6	3.1%
Bedil Lapis – larger	4.8	183.5	2.6%
Bedil Lapis – smaller	4.5	129.0	3.5%
Sabah Museum No.1026	5.3	167.6	3.2%
Sabah Museum No.1039	4.6	174.0	2.6%
Sabah Museum No.1040	4.3	172.7	2.5%

Harrisson applied his ratio criterion to each different type of cannon in the Brunei Museum collection, excluding the *gargabus* and *naga* types, due to their unique muzzle shapes (see details in Harrison 1969:110–111). His focus, however, was mainly on *bedil* type cannon. He calculated the bore-to-length ratio for six *bedil* cannon from the Brunei Museum and three from the Sabah Museum and found that the rounded results were consistently 3% (as whole a number) (Table 1). He calculated ratios of 5% and 7% for two comparable European—possibly Dutch—cannon, which showed a marked difference. Such results tantalisingly suggests that cannon in Brunei (and perhaps other nations) were, to some extent at least,

[3] The variables E (overall length) and H (bore diameter) are taken from the Underwater Archaeological Research Section Cannon Data Sheet (see Appendix 2).

standardised, and that it may be possible to quantify this practice and use criteria such as Harrisson's ratio to identify Bruneian made guns. Surprisingly, despite this potential, Harrisson's approach does not seem to have attracted much attention from other scholars. This thesis will apply Harrisson's approach to its subject cannon to evaluate the method and its potential viability as a provenance tool.

Other books about the Brunei cannon soon followed, including *Warisan Budaya: Ukiran Bedil* (Cultural Heritage: Cannon Engravings) in 1989 by Bantong Bin Antaran, which touched upon the identification of gun decorations. The latest text is simply a catalogue of the ordnance collection entitled *Bedil: Koleksi Jabatan Muzium-Muzium* (Cannon: Museum Collections) by Kipli Bulat, published in 2006. A noticeable pattern can be identified in these local publications, whereby authors engage the subject of cannon in a broad approach, but do not examine the guns on an individual basis. The danger with this approach is that it leads the public to accept the cannon as a homogenous group, without acknowledging the numerous differences in type and use, design and make, size and decoration, etc., and without delving deeper into their history, meaning and cultural significance. For this reason, this thesis will examine each selected cannon in detail and, within these details, attempt to identify variations in the gun founding techniques and production processes used to make them.

As for the gun founding artefacts recovered from Kota Batu and Terindak Island, the crucibles and bore moulds have been conserved, but little else has been done with respect to their study (Bulat 2006:8–9). Basic compositional identifications were made, but nothing was offered to relate this information to gun founding. It was determined that the bore mould clay consists of quartz, sand, paddy husk and charcoal. In addition, tree resin (*damar*) was detected on the exterior of the moulds.

Hence, the thesis will assess these artefacts and provide some interpretation of the materials and equipment in regards to the gun casting process.

CHAPTER 4
METHODOLOGY

This thesis will utilise a number of approaches to study Brunei cannon, including methods employed in related works, with some additions and modifications. It will compile and examine published sources dealing with Southeast Asian cannon, and supplement this information with firsthand accounts communicated directly by officials and staff of the Brunei Museum, Brunei Maritime Museum and Brunei Arts and Handicraft Training Centre (BAHTC), as well as observations of cannon founding demonstrations at the BAHTC.

This thesis will assess the various factors that potentially influenced Bruneian cannon (type, design, size, shape, decoration, etc.) and gun making (materials, technologies, techniques, etc.). A primary goal of this assessment will be to identify evidence for standardization in Bruneian cannon design. The study also will consider the role of ordnance in Bruneian (Malayan) history and modern society.

Secondly, this work will examine seven example cannon from the Brunei Museum and related gun-founding artefacts. The analyses of these objects will be guided by firsthand observations of the acclaimed traditional bronze gun casting practiced at the BAHTC. The study will include step-by-step recording of the casting process, with the observed techniques being mined then for insights into the museum cannon and founding artefacts. In addition, the study will explore the possible raw and alloyed materials used to make the cannon. This aspect of Brunei's cannon should prove particularly enlightening, since the country lacks metal and other resources normally associated with a flourishing metalworking industry.

By synthesising the archaeological evidence, findings of related studies and observations of traditional gun making, the historical methods employed by Bruneian

foundries, the origins of those methods and their implications regarding trade, resources acquisition, culture and customs can be elucidated.

The seven cannon selected for study are reported (with confidence) to have been recovered from the environs of the Brunei River (Kipli Bulat, personal communication 2012). The cannons are recorded systematically following the guideline of the Nautical Archaeology Society (NAS) (Bowens 2009:201–209). These include taking basic measurements, photographing and drawing each cannon. However, the cannon data were recorded on the Cannon Data Sheet produced by the Underwater Archaeology Research Section (UWARS), rather than the form offered by the NAS, since the UWARS form is much more comprehensive in data collection (see Appendix 3). This effort not only provided the key dimensions, notably bore size and overall length, needed to test Harrison's method, but it also produced an updated and detailed record of each gun for the museum.

The tools and supplies required for recording cannon include:

- note paper
- callipers
- camera
- flashlight
- photography scale
- graph (metric) paper
- magnet
- magnifying glass
- needle
- ruler (preferably with both metric and imperial scales)
- tape measure (preferably with both metric and imperial scales)

- UWARS Cannon Data Sheet

A major limitation of this study is that examination of the cannon and other artefacts was restricted to visual inspection, with no chemical or other analyses permitted. This, however, does not discredit the usefulness of the myriad data that can be observed, measured and recorded for cannon or other artefacts. Green (2006), Jateff (2011) and Wignall (1973) all comment on the necessity of detailed visual inspection and documentation of cannon characteristics and comparative assessment of attributes such as shape, design, overall and individual component dimensions, and relative dimensions such as parts offsets and placements. Sara Grace Hoskins (2006) demonstrated the effectiveness of visual observation and simple metrics in her thesis, *16th Century Cast-Bronze Ordnance at the Museu De Angra Do Heroismo*. Using basic measuring tools, Hoskins recorded a collection of nine cannon and was able to determine the method of their manufacture, casting flaws and other problems in their founding, the nation that commissioned the guns (their provenance), and other important details.

The present work will include a description of each cannon concerning their condition, physical characteristics and design, with special attention to features that might shed light on past use (whether or not the cannon was fired), casting techniques, flaws or other manufacturing mistakes, ownership, etc. Documentation will include scale drawings and photographs of each cannon and specific key features. The combining of photographs, illustrations and descriptions, including detailed measurements, will provide important baseline data for the cannon, not just for this thesis but for the Museum curators and conservators and for future researchers as well.

Cannon Typology and Nomenclature

As previously mentioned, the latest typological characterisation by the Brunei Museum of the Southeast Asian cannon in their collection is a contentious matter. It is known that most of the cannons in the collection were recovered from within Brunei Darussalam. By making such categorisation based primarily on length, which disregards gun type, make and design, the typology becomes subject to gross generalization and void of any useful meaning. For the sake of simplicity and clarity, this thesis will use Shariffuddin's typology for naming cannon type, but the Museum's length category also will be noted.

In addition, a reassessment of the term *bedil buloh* (bamboo cannon) must be made due to its confusing nature. Shariffuddin (1969:78–81) states that *bedil buloh* was a term for a completely smooth cannon or one with little decoration. However, in the article itself, he uses the term for highly embellished cannon as well. For clarity sake, *bedil buloh* in this thesis will refer only to undecorated cannon, whereas Shariffuddin's highly decorated *bedil buloh* will be labelled *bedil buloh* (highly decorated), or *bedil buloh* (HD).

Limitations

Research for this thesis was limited by the study permits granted by the Brunei Museum, Brunei Maritime Museum and BAHTC. Although the Brunei Museum holds 721 cannon in its collection, only seven were made available for examination. These seven guns are the only ones known with some level of confidence to have been recovered from the Brunei River, although no written records confirming this exist, merely the recollection of Museum officials (Kipli Bulat, personal communication 2012). The original provenances of the cannon are not known, nor are their pre-depositional contexts. This restriction is responsible for the exclusion

from the study of two types of cannon: *bedil naga* and *bedil lapis*.

The seven cannon that comprise the study set are:

1. Cannon 1966-219 – *Bedil Buloh*
2. Cannon 1966-366 B – *Bedil Buloh* (HD)
3. Cannon 1966-840 – *Bedil Gargabus*
4. Cannon 1969-36 – *Meriam*
5. Cannon 1973-9 – *Bedil Buloh*
6. Cannon 1974-66 – *Meriam*
7. Cannon 1967-X – *Bedil Buloh* (HD).

The cannon identification numbering system is a combination of the four-digit year that the cannon was acquired by the museum followed by a unique registration number. Thus, cannon 1966-219 was accessioned into the museum's collection in 1966 and assigned the registration number 219. Note that the registration number of cannon 1967-X has been lost, but it is known that the gun was acquired in 1967.

Another limitation of this study was the inability to sample or scientifically analyse the cannon or other artefacts, including even the use of non-destructive diagnostic methods such as x-ray scanning and magnetic resonance imaging (MRI). This not only prevented the material identification of the cannon and their component parts, but it also proscribed analyses that could shed light on the cannons' depositional history. Visual inspection alone is not sufficient to confirm if the cannon came from a marine environment, since water has limited effect on bronze in terms of discolouration and degradation (Bowens 2009:203). On the other hand, simple chemical tests could (Jateff 2011:7) The only insight regarding metal composition of the cannon was to test for iron using a simple magnet, and to record the colour(s) of the metal through visual inspection with a flashlight. Both of these observations are

noted in the cannon descriptions.

Finally, BAHTC and Museum officials imposed restrictions on what could be photographed of the gun founding process and of the guns and artefacts themselves, and what measurements could be taken and reported. The reasons they gave were security concerns and to avoid giving the public too much knowledge about making firearms. Where such restrictions occurred, detailed descriptions, approximate measurements, estimates and sketches had to suffice. When particular artefacts could not be photographed, images published in earlier works, where available, were used.

CHAPTER 5
CANNON USE AND ITS INFLUENCE ON DESIGN

As noted by Alex Teoh (2005:11), "The Borneo cannon maybe of shorter firing range and lighter in weight but excels in ornamentation and design. This may due to the function and role the cannon serves in Borneo Island and its neighbouring island". This chapter will discuss how the use of Southeast Asian cannon in Brunei (Malay) culture and society affected the guns' designs.

Throughout their history in Brunei, cannon have been much more than mere weaponry; they have been an open canvas for the caster to practice his art, embellishing the guns with ornate designs that impart symbolic meaning and enhanced value for those commissioning the pieces. Much like their European equivalents, cannon in Brunei played an important role in public ceremonies, were used as symbols of political power and elite social status, were decorative elements, and, of course, were a critical component of warfare. With regards to warfare, cannon designs were modified based on their intended deployment. As Mauncy (1965:49) and Cipolla (1965:75) state, cannon differ in size and shape depending on the terrain in which they are used. One such example is cannon employed onboard ships, which are made considerably longer than those used on land.

Cannon as Weapon

In most cases, the primary role of cannon is to serve as artillery; that is to say, as a weapon of war, whether for offensive or defensive purpose. However, within this broad assignment are myriad factors that require different types or sizes or make of cannon, and which place specific demands on gun founders and their craft. As Mauncy (1965:49) and Cipolla (1965:75) have stated, cannon differ in size and shape depending on the terrain in which they are used. One such example is cannon

employed onboard ships, which are made considerably longer than those used on land.

In general, the Brunei Museum collection consists mainly of swivel guns rather than large cannon. This is likely a response to the local environment in which Bruneian cannon were employed. Historically, the rivers and coastal waters of Brunei and greater Borneo have provided the principal means of transportation and communication between peoples and settlements. Thus, smaller boats, such as the *prau*, have been the most popular and efficient type of watercraft used, since they can better manoeuvre in these shallow and often confined waters. These boats, in turn, require smaller cannon that can be operated in limited space by fewer men. Large cannon, by comparison, are too cumbersome and difficult to man on such craft, and would simply be too heavy for the boats to support.

Gun makers also had to adapt their cannon to fit the battle strategies and warfare tactics employed by the early Bruneians. Warships and fortresses had long been part of warfare in Brunei, and the evidence shows that, rather than drastically changing established tactics, the introduction of artillery simply reinforced them. In other words, the cannon were selected or modified to fit the demands of traditional Bruneian combat.

An important element of terrestrial warfare in Borneo was the use of temporary makeshift stockades called *kubu* (meaning bulwark or bunker). *Kubu* were three-walled structures made of logs and earthen fill, with the rear of the structure left open to allow for strategic withdrawal or other tactical movements (Andaya 1992:43–45). They could be built quickly and were used to halt or at least hinder the advance of an enemy force. If the *kubu* was about to be overrun, its occupants could abandoned their position as quickly as they had created it. Mobility was key to this tactic and to

the use of these fortifications, and this favoured smaller, more portable guns; large cannon were simply too cumbersome to be of practical use. When larger artillery was employed on land, typically it was stationed atop an earth mound, with little intent to being moved (Sanders 1982:73).

As for assessing cannon use at sea, it is necessary to begin with a look at traditional Brunei watercraft. By at least the eighth century, but possibly earlier, Brunei was building seagoing vessels (Saunders 2002:22). However, the earliest known record of Brunei vessels and their construction was by Pigafetta, during his visit to Brunei in 1521 as part of Magellan's expedition:

> Those junks which are the ships of those people are made in this manner. The hull stands about two palms high [*f.* 61'] in the water, and is of large planks fastened with wooden pegs, very well made, and they are covered over all with bamboos. And one of those junks carries as much cargo as a ship. On each side are very thick bamboos as a counterweight. Their masts are of bamboo, and the sails of the bark of trees [Pigafetta 1994:102–103].

Pierre-Yves Manguin (1993) refers to these junks as Southeast Asian hybrid vessels, since they exhibit a mixture of Chinese and Southeast Asian shipbuilding characteristics. In general, they are built without iron, being fastened primarily by wooden dowels, with planks stitched together using plant fibres. They are fitted with a keel and the hulls are V-shaped. As Manguin (2001:13) points out, however, none of these ships excavated to date fits all these criteria.

A record of a Chinese shipbuilder operating in the region suggests that junks of up to 600 tons could dock at the mouth of the Brunei River (Krausse 1995:265; regarding the shipbuilder, see Haji Yahya 2007:2; Manguin 1993:198). There also is

archaeological evidence from a sixteenth-century *tongkang* (a type of lightering boat) found at Limau Manis in Brunei (Haji Yahya 2007:6). Although study of the ship is still ongoing, its construction method has been identified. The boat was fastened primarily with wooden dowels and ligatures made from *luba* palm tree roots and *rattan*.

The evidence then argues that Brunei had ships large and sturdy enough for large cannon to have been mounted on them. Why then, if this was the case, does the Brunei Museum collection consist primarily of swivel guns of less than three-meter length; were larger cannon not used as main weapons?

Most likely, the answer is that these large junks were simply outmatched by European warships and unable to defend against them at sea (Charney 2004:128–130; Manguin 1993:208). Thus, smaller, lighter and more manoeuvrable "war boats" were used to harass the large European vessels. Unfortunately, no remains of such boats have been found in the Borneo region. Thus, we are forced to rely upon historical documentation of nineteenth-century fighting vessels.

Warships

Perahu Perang, a term loosely translated as "warship", was a particular type of vessel used in the Castille War against the Spanish, who referred to such boats as galleots and galleys. This differentiation was based on a vessel's size, indicated by the number of benches for paddlers. A galleot had eighteen benches and was equipped with falconets and culverins (Beltran as cited in Nicholl 2007:46), whereas galleys were war vessels sporting twenty-four benches or more (Manguin 1993:212). According to some reports, 200 such vessels—100 galleots and 100 galleys—were deployed against the Spanish, along with 7,000–8,000 men. The personnel contingent alone, averaging almost 40 men per vessel, indicates a substantial size and

carrying capacity for this type of vessel.

Comparable nineteenth-century warships were larger, having a typical contingent of 70–80 men, were oar-powered, and had a longitudinal roof-like fighting platform upon which warriors were stationed (Figure 5) (Haji Yahya 2005:39; Marryat 1848:64). Surprisingly, although these boats were equipped with cannon, these were not the main weapon. Warriors onboard used spears, blowpipes and guns, which they launched or fired from the fighting platform, and were armed with *keris* (asymmetrical daggers) for close, hand-to-hand combat.

Pirate Boats

Brunei has a long history of piracy, such activity being recorded as early as the seventh century (Nicholl 1990:30; Saunders 2002:22). However, it is in the nineteenth century that piracy truly flourished in Borneo (Marryat 1848:64; Mundy 1848:12–13; Young 2007:35). The three types of boats favoured most by pirates were *lanong, garay* and *salisipan* (Warren 1985:44–45).

Lanong, typical to Brunei and Sulu, was the earliest type. It was a manoeuvrable sea-going vessel measuring approximately 20–25 m long and 6 m in beam, and was propelled both by oars and large rectangular sails (Figures 6–7). Details of it are as follows:

> Much of the interior was occupied by a fighting platform and cabin. There are also a captain's quarters and powder storage ... armaments consisted of a strong bulwark at the bow mounting cannon (6 to 24 pounder) as well as several swivel guns. The crew consisted of 150–200 men, with the warrior-sailors occupying the upper platform [Warren 1985:44].

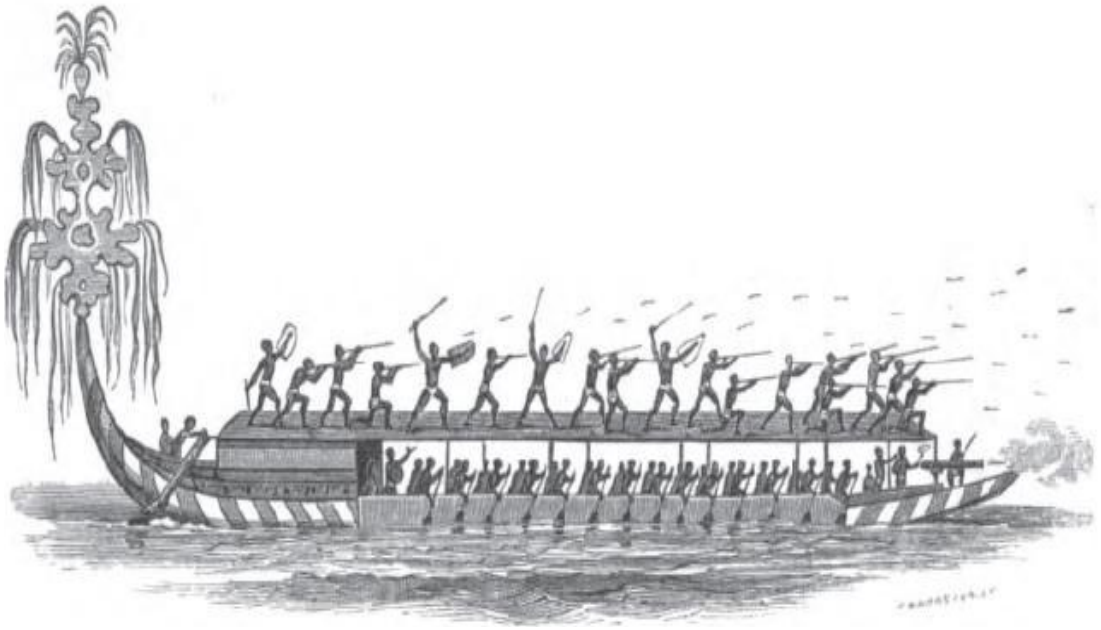


Figure 5. Illustration of a Dyak/Malay warship (Marryat 1848:64).

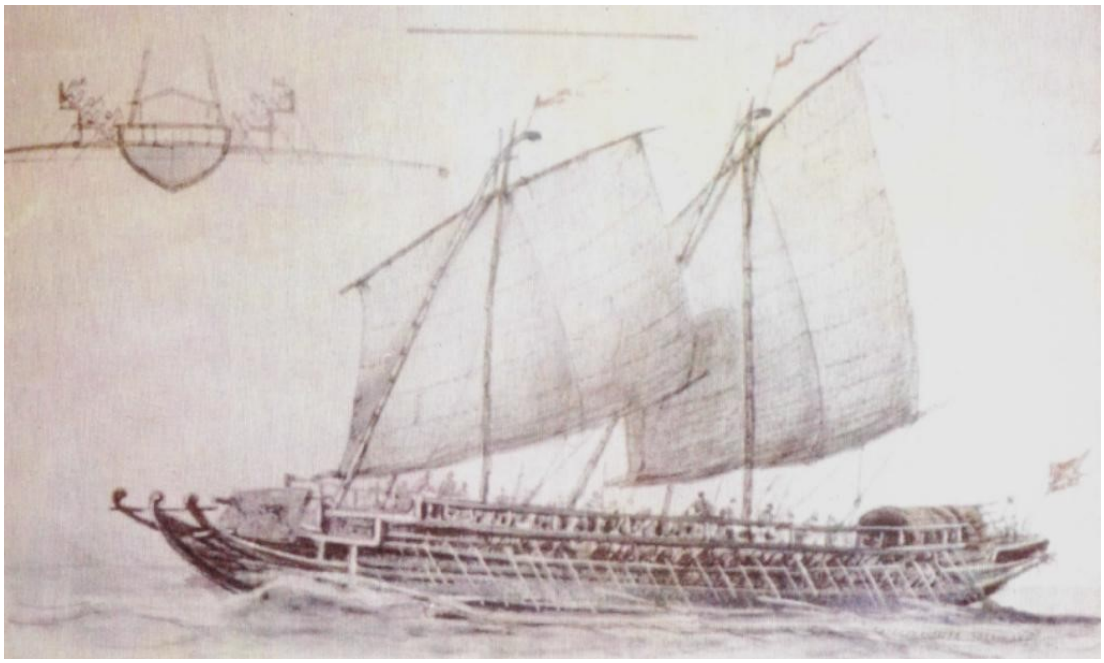


Figure 6. A *lanong* type vessel with two forward-facing cannon mounted at the bow (from Warren 1985:46).

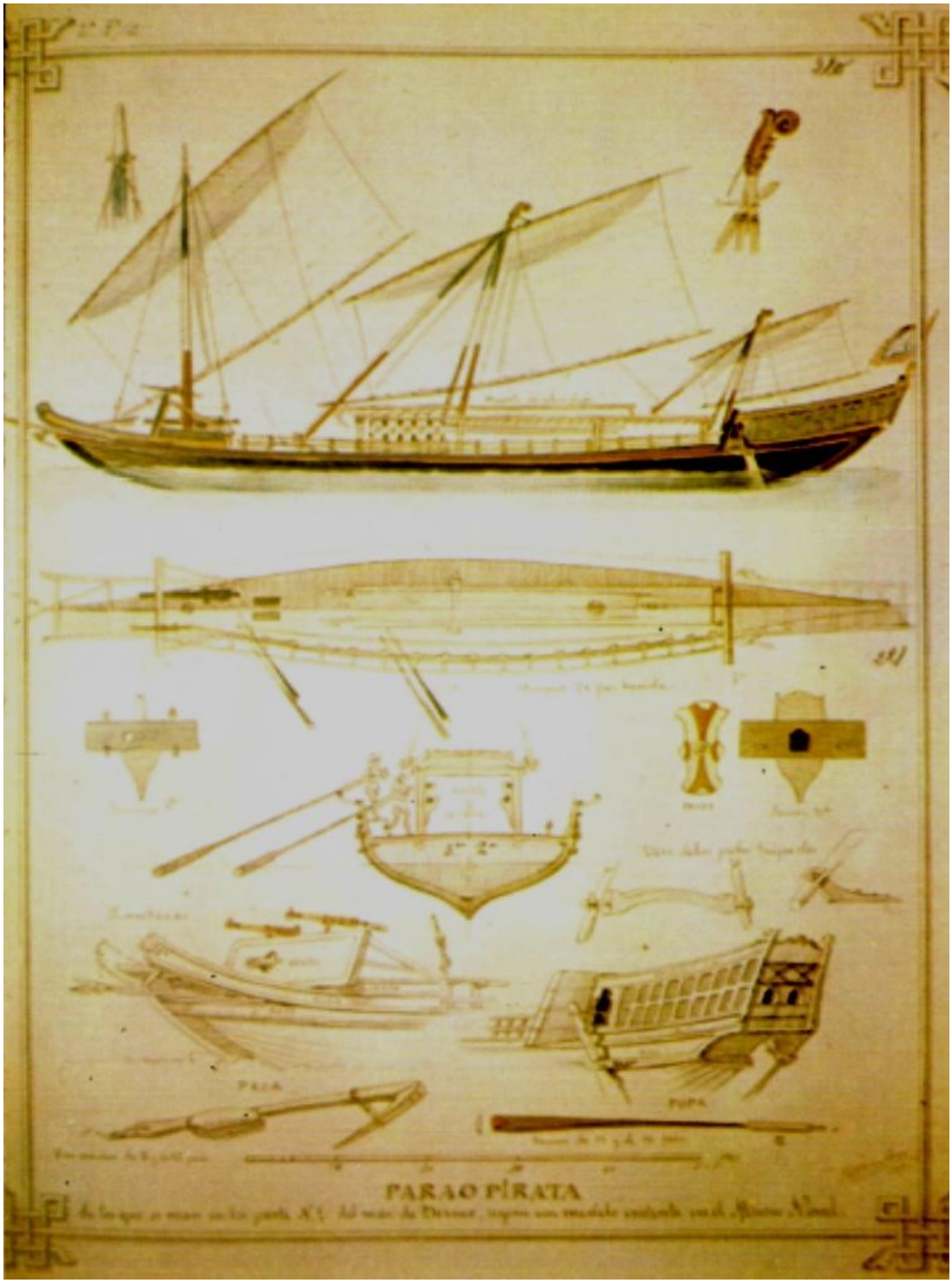


Figure 7. Illustration and construction drawings of a *lanong* (from Warren 1985:49).

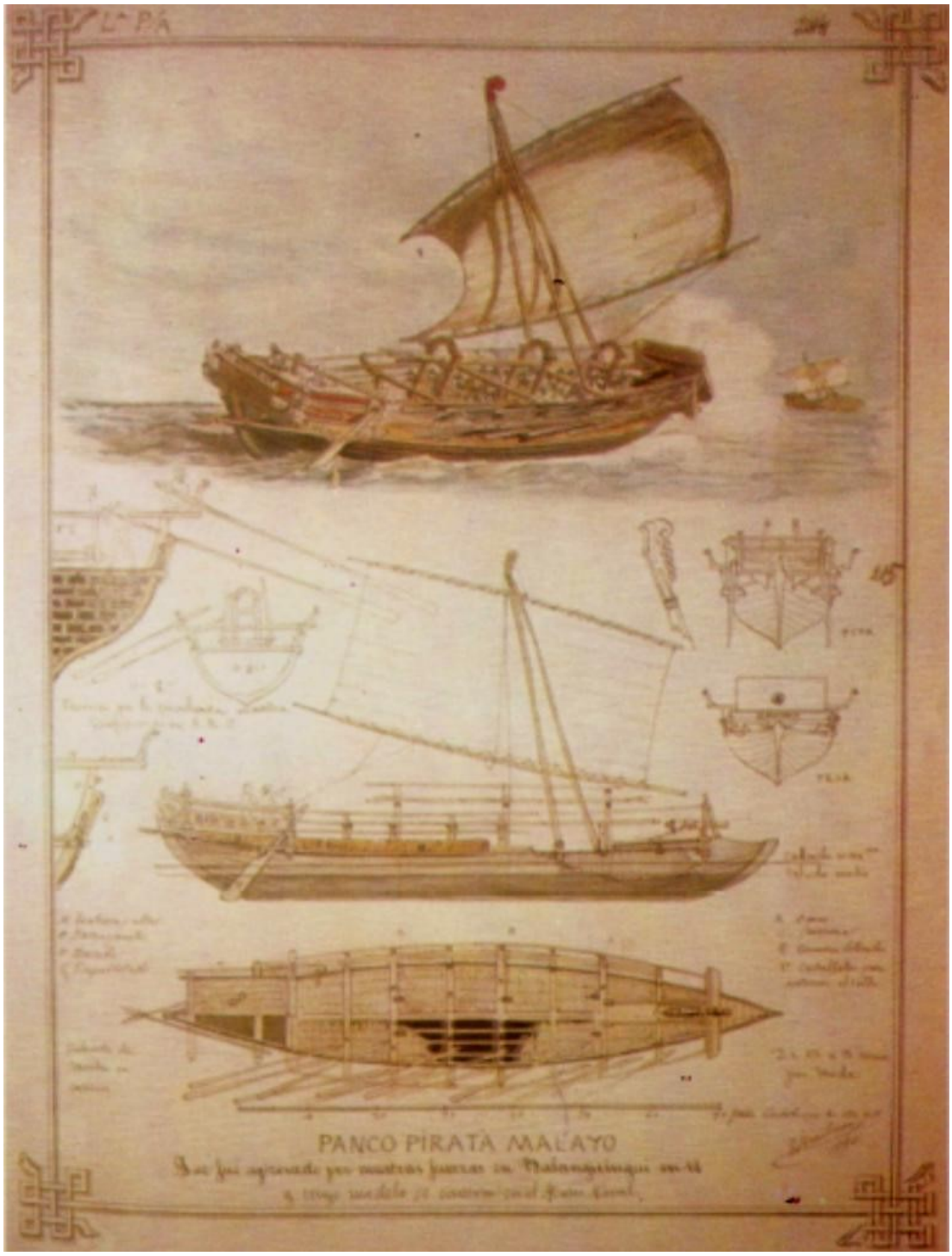


Figure 8. *Garay* ship illustration and construction drawings (from Warren 1985:50).

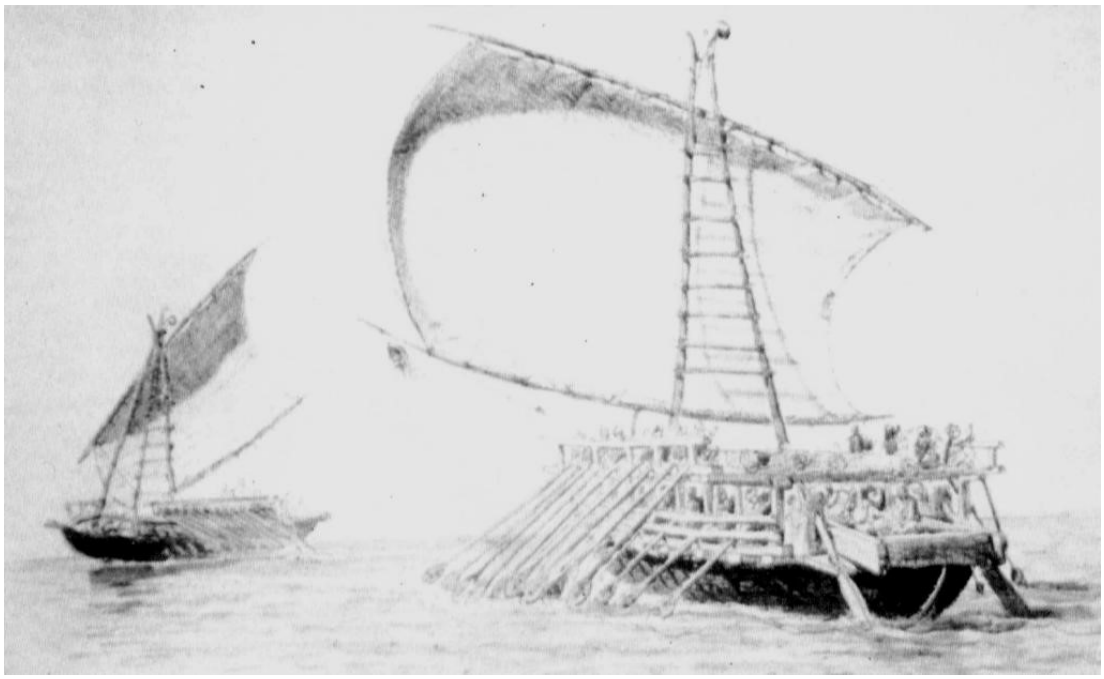


Figure 9. Illustration of two *garays* (from Warren 1985:47).

Figure 10. Illustration of two *salisipan* under oar (from Warren 1985:49).

Garay type vessels mostly replaced the *lanong* in the mid-nineteenth century. The *garay* was "a ship of the same size, but of lighter construction, so that it drew less water and therefore [was] faster... For armaments a fixed gun was carried in a bulwark at the bow" (Figures 8–9) (Warren 1985:45). The third type of boat was a *prau* known as *salisipan*. These were smaller, more manoeuvrable oared boats used to advance up river channels where the larger *garay* and *lanong* were difficult to handle (Figure 10). They too are depicted with cannon mounted fore and aft.

Based on the illustrations of these fighting vessels, certain similar traits are evident:

- the ships lack gun ports for side-mounted cannon, the room instead being used for oarsmen, and thus speed;
- the boats have a raised platform;
- substantial numbers of warriors and projectile weapons are their main modes of attack;
- cannon placements are primarily at the bow.

The boats also have pointed bows, and some have rams or other forward projections. This feature and with the reliance upon warriors armed with *keris,* as well as projectile weapons, indicate that the battle tactic of choice was to ram and board the enemy's ships, much like how Chinese war-junks were employed (Charney 2004:125; Cipolla 1965:124–126). Cipolla (1965:124–126) also notes the similarities between Brunei vessels and Chinese war-junks, which also have high castles, lack gun ports and are oar-propelled. Owing to their history of interaction between Chinese and Bruneian artisans, specifically in boat building, and the influence this had on Bruneian vessels, it is not unreasonable to assume that the Bruneians copied Chinese naval tactics as well. However, with regards to the bow placement of the

cannon, one cannot but think of sixteenth-century Mediterranean war galleys and suspect a strong European influence as well (Guilmartin 1974:298–300).

Looking at the fighting styles and vessel of the sixteenth century, and the evolution from *lanongs* to *garay*, what becomes evident is a trend in Bruneian ships to smaller and lighter vessels with greater speed, manoeuvrability and versatility. This same development of smaller and lighter ships meant that the number and size of cannon they carried decreased as well. The reduction of cannon weight onboard ships meant obviously complemented the emphasis on speed and agility. But perhaps smaller guns also were a result of the trend in ship size; smaller artillery were faster to load and fire, easier to aim and more versatile, being that they were adaptable to close quarter fighting as anti-personnel weapons once boarding was underway. They also were adaptable to land warfare, city defence or other styles of combat due to their portability and relative ease of handling. Eighteenth–century records attest that an individual soldier could fire this cannon by supporting it on his shoulder, much like present day bazooka (Charney 2004:55).

Cannon as Symbol

Beyond their purely practical use as weapons of war, cannon also played important roles as status symbols and spiritual talismans. Cannon were installed on boats as decoration and to represent or enhance the status of the boat owner. The more decorated the cannon, the greater the represented wealth and prestige of the owner. But the tradition of cannon on boats goes even deeper than this measure of status; according to Bruneian culture, a vessel without cannon is not complete, is not whole. For this reason, boats are provided with cannon—whether 'workable' or not being unimportant—as part of the building and commissioning process. A misunderstanding or lack of awareness of this tradition has lead many Westerners or

others unfamiliar with Brunei culture to consider such non-functioning cannon as 'fake', where, to the Bruneians, the cannon are perfectly fulfilling the purpose for which they were made.

Similarly, spiritual beliefs have had a great impact on cannon shape and decorative design (Harrisson 1969:105). Cannon in Southeast Asia are used not just to ward off humans and animals, but spirits as well (Reid 1988:128; Sanders 1982:75). Such beliefs were prominent in Brunei, especially regarding cannon shaped like crocodiles, and those with dragon shapes, which served to fend off supernatural beings. Some cannon even are given offerings, such as in Thailand, where a cannon called *Phra Phirun* (Rain God) was presented with flowers and incense (Andaya 1992:49).

Cannon as Currency

Among the natives of Brunei, cannon functioned as currency. The guns were traded, used to pay off fines and given as dowries, as was the custom of Brunei's native *Dusun* people (Shariffuddin 1969:91). Cannon were valued based on their weight in *pikul*, with one *pikul* being the equivalent of 60.5 kg (Bulat 2006:16–17). An ordinary gun with standard decoration had a typical value of $25–$30 (Straits Dollar)[4] per *pikul* (Sanders 1982:75; Woolley 1947:37). The more embellished a cannon was, the more value it had. Some credit this for features such as dolphins (*kanching lumba-lumba*), believing them to be purely ornamental (Gardner 1936:93; Shariffuddin 1969:88). The value of cannon came from the inherent worth of the bronze metal itself, the skill required to cast and embellish it, the military strength it represented and its associated spiritual powers and symbolisms. These factors and

[4] Straits Dollar was the currency of the region from 1904–1939, after which it was replaced by the Malayan Dollar.

others imparted cultural significance to cannon and made them valuable and desirable as currency, but it was the small size of these guns—their portability—that ultimately facilitated their practical use as currency.

Cannon as Signalling Device

Cannons in Brunei also were used as communication devises to convey messages to the people. They were used for signalling and warning, but also for more jubilant occasions such as royal ceremonies. To be effective in this role, the signalling cannon would need to be placed in a conspicuous location, such as on the battlements of a fort, atop a riverbank, or on an overlooking hill. And, most obviously, they would need to be loud.

Shariffuddin (1969:89) suggests that *bedil gargabus* would have been particularly well suited for this purpose. These cannon have a flaring muzzle that resembles the shape of a trumpet or horn. It is possible that this trumpet muzzle produces a greater and farther carrying sound than the normal *bedil buloh*. However, short of actually firing different types of cannon and measuring the decibels of their blasts, proving this will be difficult.

Assessing the various factors that affected the make and style of cannon, it would seem that these weapons developed more organically, through cultural stimuli, rather than through any deliberate program of improvement. This may have been one of the reasons why standardization of cannons was never a priority. Yet, there could still have been a rule of thumb measurement—a minimum standard, so to speak—to which these gun founders adhered, at least in terms of reliability and safety (for the gunners). The following chapter will discuss further this possible ‘standard’ with respect to ammunition and gunpowder.

CHAPTER 6
GUNPOWDER AND AMMUNITION

This chapter provides a brief description and assessment of gunpowder and ammunition used in Southeast Asia. This review is regional wide and not limited to Brunei alone, due to the paucity of relevant evidence and records. It is important to tackle these subjects, as the gunpowder and ammunition—propellant and projectile—used with the cannon had a direct effect upon their design and standardization (Guilmartin 1982:140; Hoskins 2003:33; Mauncy 1965:25).

Gunpowder

"If there had been an absence of gunpowder and cannons, the history of Brunei would have been very different" (Shariffuddin 1969:89). Cannon and gunpowder are inseparable. It is unlikely that the invention of gunpowder, like so many other inventions, can be ascribed to a single person or one particular region. As mentioned in chapter 2, when cannon arrived in Brunei, gunpowder must certainly have come with it. Although opinions vary as to whom should receive credit for the discovery, all of the countries mentioned proved to be self-sufficient in the making of gunpowder and could have easily introduced it to Southeast Asia.

At first, gunpowder, as its name suggested, was simply dry powder mixed from its component ingredients—saltpetre, charcoal and sulphur. After the mid fourteenth century, European manufacturers improved gunpowder and its production by adding liquid to the mixture during grinding. The dampened powder, or millcake, was then shaped by hand into corns—grains the size of corn maize—and left to dry. Due to its lower surface area, corned powder absorbed less moisture and thus could be stored longer before being used. It also was more powerful and easier to load into guns, which translated into longer (and deadlier) range and increased firing rates

(Guilmartin 1982:140; Mauncy 1965:23). From the beginning of the nineteenth century, powdermakers further improved the production process by mould-pressing the millcake to remove the liquid and make the cake denser. This presscake was then broken into tiny pieces, which were sorted into uniform sizes with sieves; the coarse powders being used for cannon (Guilmartin 2003:109–110, 298–300).

Due to such innovations, European gunpowder was superior to the powder made in Southeast Asia. It is even recorded that Southeast Asians preferred to buy European gunpowder even when they were capable of making their own (Andaya 1994:37; Mostret 2007:37). Even in the early nineteenth century, gunpowder from the Malay region was still inferior to European-made powder (Marsden 1811). The primary culprit seems to have been the granulation of the powder, since Southeast Asian and European gunpowder used basically the same composition.

Though there is no physical evidence or even historic accounts of gunpowder mills in Brunei, it is not surprising that the country was capable of making its own gunpowder. Saltpetre could have been obtained from goat dung, which was plentiful (Charney 2004:62; Marsden 1811), and charcoal was easy to obtain locally. In addition, coal may have been used in place of charcoal. At least in the nineteenth century, coal was mined along the Brunei River and in Brooketown, present day Muara (Figure 11) (Haji Jibbah 1980:105; McArthur 1987:101). As for sulphur, although there is no mineral source in Brunei, greater Borneo is rich in sulphur and it would have been easily procured (Encyclopedia Britannica 2012; Mitchell 1840: 582).

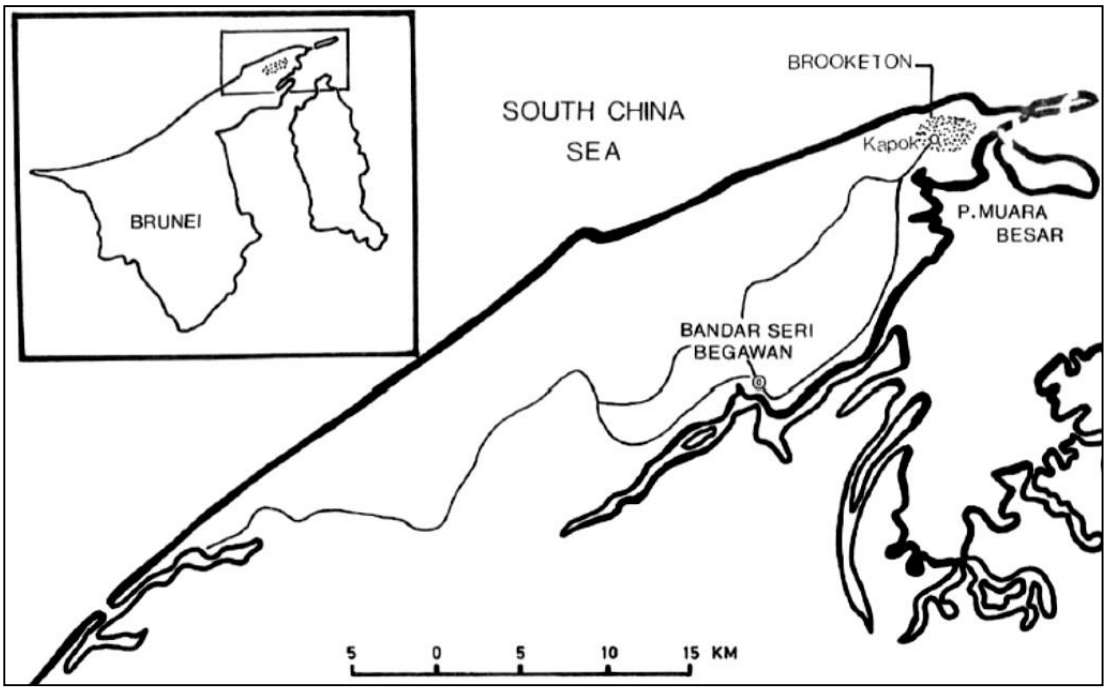


Figure 11. Location of a coal deposit in Brooketown, present day Muara (from Haji Jibbah 1980:104).

Malayan gunners primarily used linstock to discharge their cannon, which were fitted with slow match, or match cord (*tali api*, literally, fire string), typically made from coir (fibres) of coconut husks (Gardner 1936:97). In Europe, by about the seventeenth century, match cord was three-strand cotton rope treated with saltpetre or lead acetate and lye (Mauncy 1965:26). European match cord is said to have burned at a rate of about 10–13 cm (4–5 in) per hour. As part of this research, a burn experiment was conducted at the Brunei Maritime Museum using coir match cord made by braiding three strands of coconut coir, approximately 3–5 mm thick. The cord burned at the rate of 8–10 cm per minute. Although this indicates that coir burned much faster than European slow match, it still would have been useable. The advantages of using coir are that coconut is abundant throughout Brunei and coir cord is quick and easy to make. Another important attribute of coir is that it is fairly water resistant. As part of the burn experiment, the coir cord was sprinkled lightly with water, but continued to burn.

Ammunition

The majority of the Southeast Asian cannon in the Brunei Museum collection are muzzle-loading and ignited from the breech. There are varying views on the type of ammunition used by Bruneians prior to the eighteenth century, and on the size of this ammunition (i.e., the bore size of the cannon). Cannon of lore, such as the one Sultan Abdul Hakkul Mubin used to blast the Bruneian royal crown across the sea, and the gun *Si Gantar Alam*, which caused the whole realm to tremble when fired (Shariffuddin 1969:74), suggest the presence of large calibre cannon in Brunei's arsenal. However, no cannon of such implied magnitude have been found in Brunei. The largest type mentioned in regards to the country is the saker, which had a barrel approximately 2.9 m (9.5 ft) long, a bore calibre of 8.3 cm (3.25 in), and fired round shot weighing 2.4 kg (5.25 lb). (Beltran as cited in Nicholl 2007:45; Mauncy 1965:35).

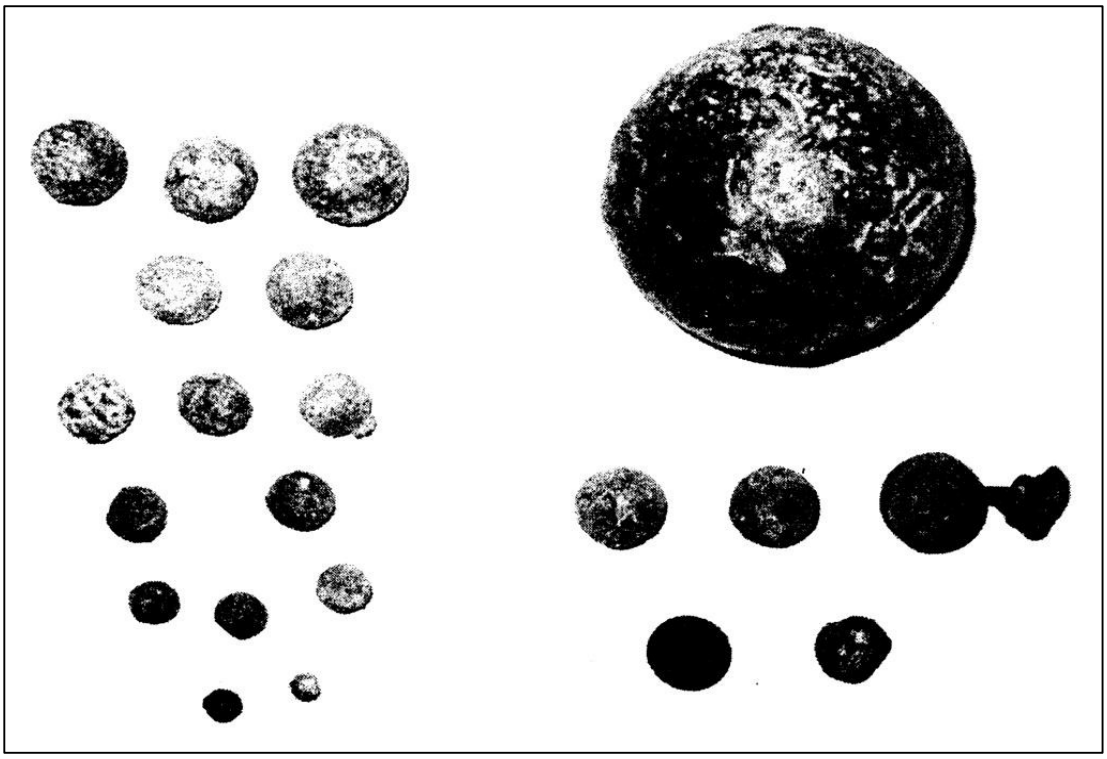


Figure 12. Examples of Southeast Asian cannon shot (from Teoh 2005:20).

Many different types of cannon shot have been used throughout the world, but they can be grouped mostly into the following categories (Mauncy 1965:63):

- battering projectile;
- exploding projectile;
- scatter shot;
- incendiary and chemical projectile.

Little is known about the gun ammunition used in Southeast Asia. While it is possible that it was similar to that used in other parts of the world, the type used mainly by Malays was stone, although evidence of iron and brass cannon balls has also been found (Gardner 1936:97). Apart from the use of solid shot—the universal battering projectile, whether stone, iron or brass—is that the Bruneians used scatter shot (Mundy 1848:33), which was packed in canisters made of *rattan* (Gardner 1936:97). This was the ammunition used in the *bedil gargabus,* with its large muzzle (Shariffuddin 1969:89). The windage created by the gun's flaring muzzle caused the shot to spread out as it exited from the barrel, making the gun an effective anti-personnel weapon (Lavery 1987:95).

So what can be surmised from these observations about gunpowder and ammunition with regards to Southeast Asian gun design? In light of the inferior quality of Southeast Asian gunpowder, the region's predominant use of stone cannon balls, which weigh only a third of equivalent metal ones (Guilmartin 1974:166), perhaps should not be too surprising. It may reflect an acknowledgement by Malayan gunners of the poorer qualities of the powder, and a concession to the corresponding reduction in the power of their cannon. Using lighter ammunition would at least allow them to maintain the range of their guns, reportedly up to 400 meters (Gardner 1936:93), even if the subsequent impact and damage that they could inflict was less.

Of course, the greater cost and availability of metal resources needed for metal shot should not be discounted as factors influencing the choice of ammunition.

Turning back to Harrisson's method may be useful here. Harrisson theorized that the relationship of a cannon's bore diameter (shot size) to its overall length might indicate a specific standard used by Brunei cannon maker. As discussed in chapter 3, Harrisson believed that Brunei cannon were standardized by a 3% bore-to-length ratio (Table 1) However, the Harrisson's ratios calculated for other Southeast Asian cannon from outside Borneo show that there is little difference between groups and that no specific ratio is exclusive to guns from Southeast Asian or Brunei (Tables 2–4).

The bore-to-length ratios average 3.1% (Brunei Museum), 2.6% (Museu Militar de Lisboa), 3.6% (Carronade Island) and 2.8% (Museum and Art Gallery of the Northern Territory), and the overall average of all the guns is 2.7%. The largest bore-to-length ratio is 4.2% for Carronade Island gun no. 1, which is a European style cannon (Green 2006:2) Besides this specimen, no other gun in these collections has a ratio larger than 3.8% (the larger *Bedil Buloh* of the Brunei Museum). The guns tend to have bore calibres of around 3% of their overall length, with a maximum relative bore diameter of about 4%. Rather than a particular rule-of-thumb or standardised design criterion followed by Southeast Asian cannon founders, these values probably reflect optimum design criteria for optimising a gun's performance.

Adrian Caruana (1997:220) and Brian Lavery (1987:95) researched relative bore and length dimensions and their impact on performance and found it problematic to pinpoint specific causes and effects. However, apart from serving as convenient criteria for cannon classification, both men suggested that the bore-to-length ratio correlates directly with a cannon's firing effectiveness. A cannon must have

Table 2. Cannon Data from Museu Militar de Lisboa (Manguin 1976)

Cannon	Bore H (cm)	Length E (cm)	Harrisson Ratio H/E (%)
Pièces A	3.5	131	2.7
Pièces B	3.5	135	2.6
Pièces C	2.0	69	2.9
Pièces D	2.0	87	2.3
Pièces E	4.0	168	2.4
Average Bore/Length Ratio			**2.6**

Table 3. Cannon Data from Carronade Island (Green 2006)

Cannon	Bore H (cm)	Length E (cm)	Harrisson Ratio H/E (%)
Gun no.1 (European design)	4.6	109.4	4.2
Gun no. 2	3.3	109.9	3.0
Average Bore/Length Ratio			**3.6**

Table 4. Cannon Data from the Museum and Art Gallery of the Northern Territory (Davie 2009)

Cannon	Bore H (cm)	Length E (cm)	Harrisson Ratio H/E (%)
IND 295	2.7	102	2.6
IND 364	3.0	122	2.5
IND 371	2.2	88	2.5
IND 373	2.5	77	3.2
IND 700	3.5	118	3.0
IND 708	2.6	78	3.3
IND 1515	3.7	148	2.5
Average Bore/Length Ratio			**2.8**

sufficient barrel length to provide enough distance (in effect, time) for the igniting gunpowder to fully combust. This combustion time is determined by the length of the barrel (i.e., the travel distance of the shot) and the speed at which the shot travels that distance, which is determined by the size (weight) and fit of the cannon shot and the explosive power of the charge. It is possible that a 3% bore-to-length ratio provides optimum effectiveness, with 4% being the upper practical limit and 2% being the lower. If this were the case, then one would expect Southeast Asia founders to adhere to these criteria, with variations depending on specific usages or conditions. Even if such criteria are only theoretical at present and yet unproven, they will be applied to the seven Brunei Museum cannon to compare them to other cannon and investigate their consistency of design.

CHAPTER 7
BRUNEI GUN FOUNDING

Brunei is believed to have been one of the main producers of cannon in Southeast Asia (Bulat 2006:8; Sanders 1982:70; Shariffuddin 1969:75), and the substantial number of cannon in the Brunei Museum would seem to confirm this. Teoh (2005:11) claims that cannon produced in Brunei were the "finest… [and]…to be of superior workmanship and finish". That Brunei still has operating gun foundries is not surprising, given its more than 400-year history with cannon.

Due to the absence of early records, it is difficult to say when Brunei established its first native gun foundry. Pengiran Temanggong is the earliest known Bruneian gun founder. He was head of cannon casting for Sultan Muhammad Shah, after the Castille Wars (Shariffuddin 1969:73). Another famed cannon maker is Pengiran Muda Binjai, who was working towards the end of the nineteenth century. Of the many cannon for which he was responsible, only one is known by name, a cannon called *Boom*, which was considered a "big toy" and probably was not a working gun (Shariffuddin 1969:84).

Founding Related Artefacts

The artefacts excavated at Kota Batu and Terindak Island include a number of complete crucibles used for melting metal, fragments of additional crucibles (Figure 13) and several presumed clay bore moulds (Figure 14) that date to the sixteenth century (Bulat 2006:9). Having examined some of the crucibles (whole and fragmentary), it is apparent that they were used for copper alloy casting, due to copper fragments embedded in their walls and the presence of a greenish coating, probably a copper corrosion residue. As for the supposed bore moulds, only four were made accessible for examination. On average, the moulds measure almost a

Figure 13. Whole and fragmentary crucibles found at Kota Batu and Pulau Terindak (Photographs courtesy of Hanapi Haji Maidin, 2012).

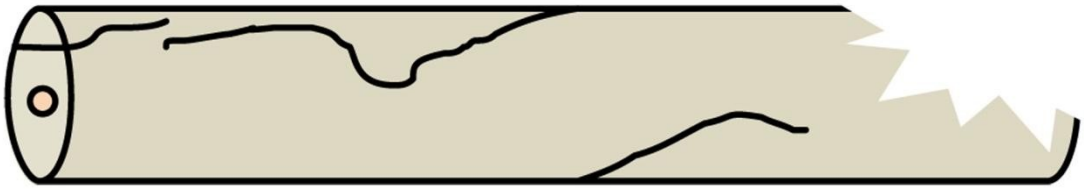


Figure 14. Sketch of one of the clay bore moulds found at Kota Batu, measuring less than a metre in length.

metre in length and 3 cm in diameter. All four moulds have a hole approximately 15 mm in diameter running through their centre. Clumps of sand with bits of clay and paddy husk were found inside the holes. The clay moulds are rather degraded, especially around the edges at each end. Cracking is prevalent on the four examined, and within the cracks traces of paddy husk are visible. Trace amounts of *damar* also were identified on the surface of two of the moulds. According to Kipli Bulat (personal communication 2012), *damar* was applied to the clay mould to help maintain its proper shape, a practice continued today.

Raw Materials

Brunei today is not self-sufficient in the raw materials needed for it to be a cannon exporter, and could not have supported its supposed historical cannon production (Harrisson 1969:94–96). However, this apparent incongruity can be explained by examining Brunei's historical territorial boundaries. Although the power of the Brunei Sultanate rose and declined several times, at its apex, between the fifteenth and seventeenth centuries, it extended across the entire north-western part of Borneo (present day Sabah and Sarawak), the Sulu archipelago and surrounding islands and much of the Philippines (CDD 2006:32, Saunders 2002:26, 31, 48–60). The country's commercial influence extended even farther afield, to the Malay Peninsula, Indochina and Indonesia, even during the eighteenth century. These territories, and the broad trade networks that linked them, were capable of providing Brunei with all of its raw material needs (Figure 15).

As to specific metals, iron is rather rare in Southeast Asia, and so is considered a precious metal in the region. This would account for the small number of iron cannon found today in Brunei and elsewhere. Southeast Asian cannon primarily are cast from either bronze or brass, since copper is more readily available locally. This

situation is reversed that in Europe, for example, where iron is more accessible and cheaper than copper and its alloying metals.

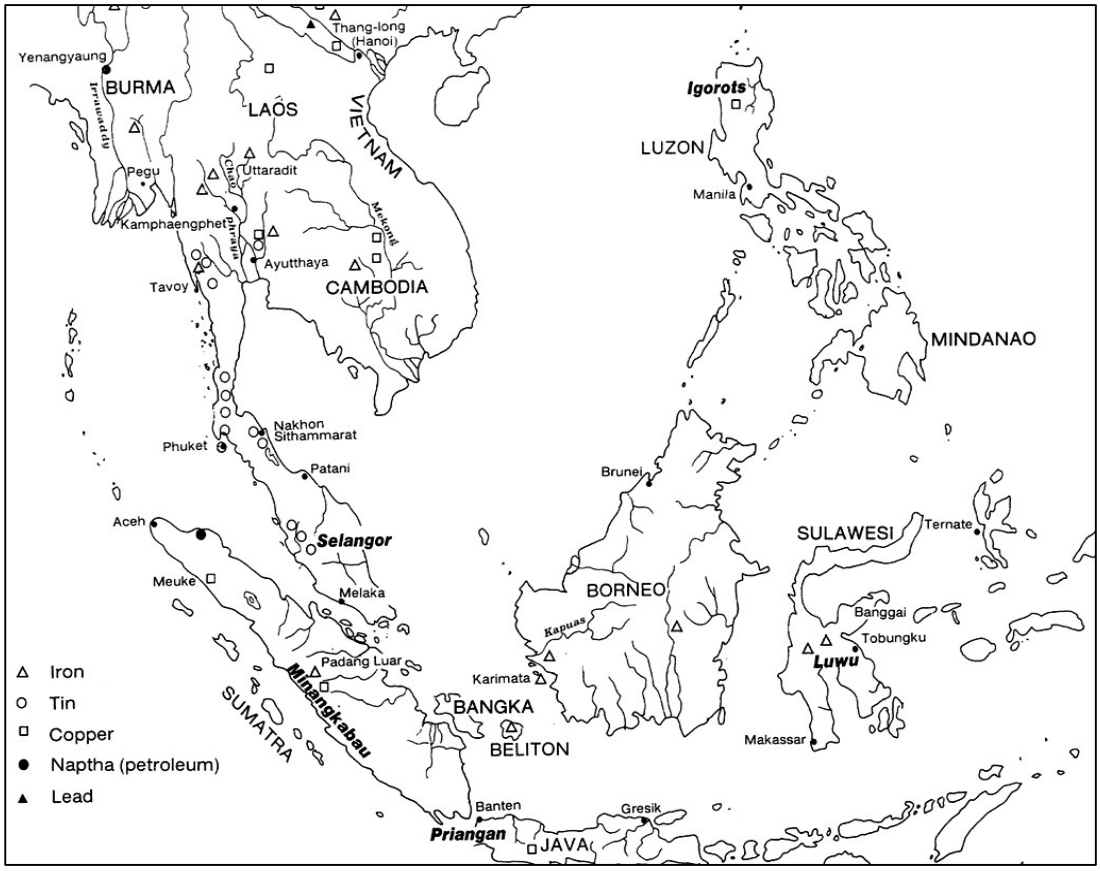


Figure 15. Source of raw metals in sixteenth-century Southeast Asia (from Reid 1988:108).

Bronze is made by alloying copper and tin in rough measures of nine parts copper and one part tin. Brass, on the other hand, is an alloy of copper and zinc. Present day Brunei has no copper deposits, but the metal can be sourced nearby from Sabah. There, copper production capacity is more than 40,000 tonnes per annum, which Harrison (1969:118) believes could represent the rediscovery of an old site. Even if copper was not mined in Sabah in centuries past, Brunei could have satisfied much of its copper demand by recycling the large quantities of imported Chinese copper and bronze objects and coins (Lim and Shariffuddin 1976:144). Chinese bronze coinage was plentiful in Brunei and Southeast Asia in the sixteenth century,

when it was circulated as legal tender (Pigafetta 1969:214; Reid 1988:115). St John Spenser (1852:298) observed this very practice in the mid-nineteenth century by Bruneian founders melted bronze Chinese coins and other items to make their cannon.

Raw tin, on the other hand, was more readily available. Tin ore today is mined in Brunei's Muara District, and may have been exploited locally in more ancient times. Another possibility is that it was procured from the western regions of Perak and Selangor in Malaysia (Reid 1988:114). The tin, like so many other trade goods, would have been transported to the commercial hub and port of Malacca and from their shipped to Brunei or other destinations.

Bronze and brass are rather ambiguous terms, and mean little more than copper alloys, since the types and proportions of alloying metals can vary greatly, especially in antiquity (Blust 1992:443, 453; Manguin 1976:251) In the case of Southeast Asian cannon in Brunei, an important and obvious example is the *bedil lapis*, whose special alloy is apparent in its unusual colouration. Unfortunately, no comprehensive metallurgical analysis of Bruneian cannon has been performed that might elucidate this intriguing question.

Another particular copper alloy used by early bronze workers to make cannon is tumbaga (*tembaga* in Malay), which combines copper with gold (Bulat 2006:243–257; Manguin 1976:251–252). Gold is plentiful in Borneo, and was so in earlier times, according to accounts by foreign travellers (Nicholl 1989:10–13). In Brunei, it was used even for general household utensils and other accessories. At present though, such gold deposits have yet to be located with Brunei's modern borders. One area of potential is in the eastern district of Temburong, although so far only iron pyrite—'fool's gold'—has been confirmed there (Wilford 1961:263). Could perhaps

mineral pyrite have been used historically—rather than true gold—in making *tembaga*? As for other possible sources of gold, the precious metal certainly was available from various parts of Borneo, and especially from the western regions of the island (Encyclopedia Britannica 2012; Reid 1988:104). The region of Landak, for example, in present-day Kalimantan (Indonesia), has a gold production capacity of 2.5 metric tons per year (Nicholl 1989:13).

Unfortunately, determining the particular metal or alloy of the examined cannon is difficult without chemical analysis. Iron can be detected using a simple magnet, but copper, gold and the hypothetical pyrite are not magnetic and have no direct positive indicator. Visual examination can often detect the presence of copper, but not necessarily whether it is pure copper or a copper alloy. As for gold, the best one that can be done on it is make note whether a particular cannon has any gold colouring, which might indicate the possibility of gold alloy.

Lastly, although it is not a metal, *damar* should be considered, since traces of it were found on two of the four bore moulds examined. *Damar* is a naturally occurring resin obtained from the trunk of the *Dipeterocarp* tree, a tropical hardwood that is found throughout Borneo. Like the rest of the island, Brunei has many *Dipeterocarp* trees and, thus, an abundant supply of *damar*. In the Kota Batu area alone, more than a thousand pieces of *damar*, both raw and worked, have been recorded (Harrisson 1972:212).

Gun Founding Process

Following is a detailed description of the traditional Brunei cannon casting practiced by the BAHTC. As mentioned above (p. 3), the Brunei government established the BAHTC in 1975 to preserve traditional Bruneian craftworks. According to Brunei Museum signage, the cannon casting tradition practiced at the

BAHTC dates to at least the eighteenth century. However, verifying the validity of this claim is problematic. At best, comparisons to European or other known metal-casting processes can provide a general dating.

Documentation of the casting process is based on observation made by the author during his visit to the BAHTC from March 3–12, 2012. Awang Haji Suhaili bin Haji Untak, a recognized casting master and teacher in the BAHTC, demonstrated the casting techniques. It should be noted that the cannon cast for this demonstration was a small (less than 70 cm long) *bedil buloh*, made only for decorative purposes. As such, certain parts of the cannon were purposely not made, such as the tubular cascabel, vent cover and yoke. In addition, certain modern tools were used, so the process cannot be considered historically accurate; this will be discussed further in the chapter.

Manufacturing the Bore Mould

The function of the ceramic bore mould is to create the internal space of the barrel, or the bore, of the cannon. It is made from a mixture of clay and paddy husks which is kneaded together for about ten minutes. The clay must be of good quality to avoid cavity formation during casting. The craftsman moulds the mixture by hand into a roughly cylindrical shape. He then inserts a wooden dowel, approximately 90 cm long, into one end of the clay cylinder. Carefully pushing and twisting the dowel at the same time, he forces it through the entire length of the cylinder until it emerges at the opposite end. He then sets the clay aside to dry naturally. The drying process takes four days, during which the mould is set outside in the sun during the day, but stored under a shelter during the night (presumably to keep it dry).

Once the bore mould is thoroughly dried, workers shape and smoothen it to the desired form using a flat-ended wooden stick and lathe (Figure 16).

Figure 16. A bore mould being shaped on a wooden lathe (from Lim and Shariffuddin 1973:152).

Cannon made using poor quality clay or "poor bronze casting technology" (Green 2006:9) typically suffer from a condition known as 'honey-combing'. This refers to small holes in the bore surface or cavities within the metal caused by casting shrinkage resulting from the inherent limitations of clay moulds and from improper casting (see, e.g., Green 2006:7 Figure 5). Surface honey-combing is particularly dangerous, since the cavities can trap smouldering material during firing, which then can cause accidental ignition during subsequent reloading, often with fatal consequences (Green 2006:9). Such cavities also produce points of weakness in the barrel and reduce the durability of the gun, which, again, poses a real danger to the gunners.

Bore moulding was practiced by European gun makers only until about 1740 (Mauncy 1965:46). Thereafter, cannon barrels were bored, or drilled, by mechanical means, which provided a stronger barrel with a smoother and more symmetrical bore. Besides allowing for better standardisation, this enabled tighter tolerance

between bore and shot, which improved cannon power. Boring also allowed for rifling, which was a major advancement in gun making. Although circumstantial, the continuation of mould casting could be considered evidence that Brunei traditional cannon making dates to the mid eighteenth century or earlier.

Making the Mould Wax

Typically, two days into the bore mould drying period, the craftsmen begin preparing the wax that they will use to coat the mould. They make the wax from *damar* resin, cow fat and honeycomb, which they combine and heat in a large wok, while stirring constantly, until the mixture becomes a homogenous liquid of the desired texture and consistency (Figure 17). The hot liquid wax turns a brownish orange colour and has a pungent odour. It is then poured through a jute sack to remove any impurities or solids. The liquid is sieved in this way repeatedly, for if any granular matter remains, it can introduce cavities and distort the cannon's shape. Once the wax is cool enough and of the proper consistence to be manipulated by hand, it is 'pulled' and stretched until it resembles string and has a thickness of about 1 cm. The wax 'string' is placed in a plastic bag and set aside to become firm.

Wax Coating

Wax is applied to the smoothed exterior of the bore mould and built up to the necessary thickness. This is done by pressing the stringy wax onto the mould with one hand while slowly turning the handle and rotating the mould with the other. This is done meticulously to ensure that each turn of wax string lays against the preceding one without any gaps. This process continues until the entire length of the bore mould is covered. Upon reaching the end, the wax string is then laid down in the opposite direction, overlapping the previous layer. This is done repeatedly until five layers have been applied. The wax-covered mould is then heated briefly over a fire to

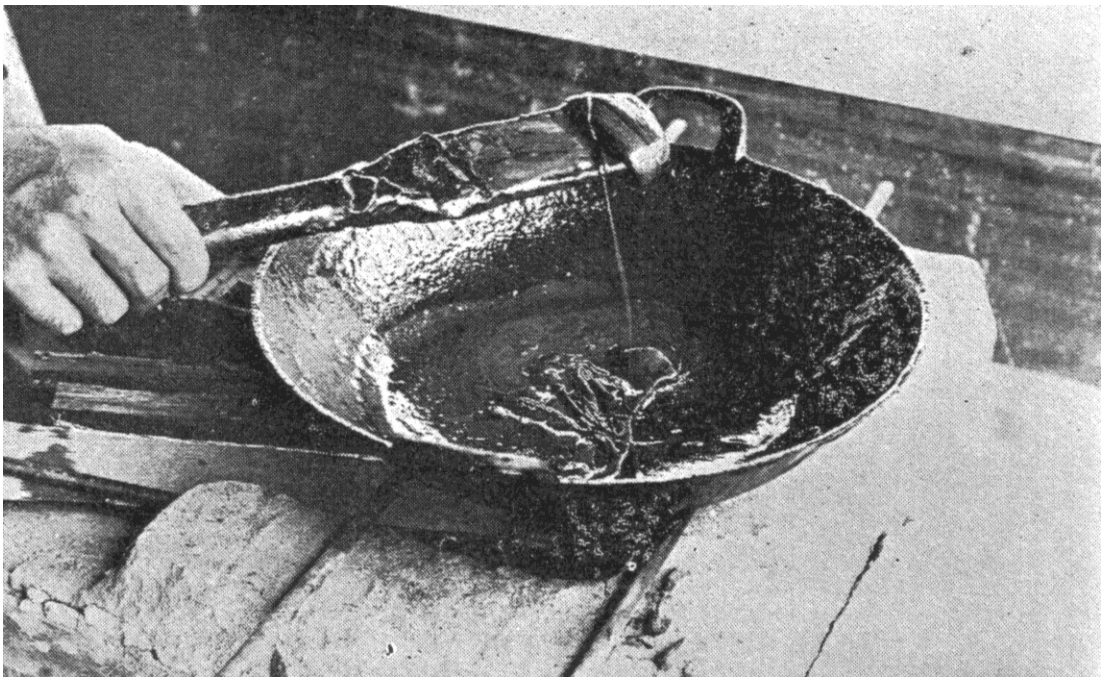


Figure 17. Mould wax is prepared using *damar* and animal fat (from Lim and Shariffuddin 1976:152).

soften the wax and make it malleable. Using his fingers, the craftsman gently presses the wax strings until they are fully fused together and no grooves are visible. Once completed, the wax covered mould is set aside to allow the wax to harden, which typically takes about half an hour.

Resuming work, the wax covered bore mould is placed again on the wooden lathe for removal of any visible imperfections and to make the wax medium more symmetrical. This is done in the same manner as smoothing the bore mould clay. Once smooth and shaped, the craftsman inscribes marker lines into the wax using a sharp stone pick, which he presses lightly against the wax surface as it rotates slowly on the lathe. These lines designate where features and decorations will be placed and are described as follows (Figure 18):

Position (1) Muzzle mark, single line scored approximately 15 cm before the bottom end of the bore mould;

Position (2) First reinforce or step feature mark, single line inscribed at the

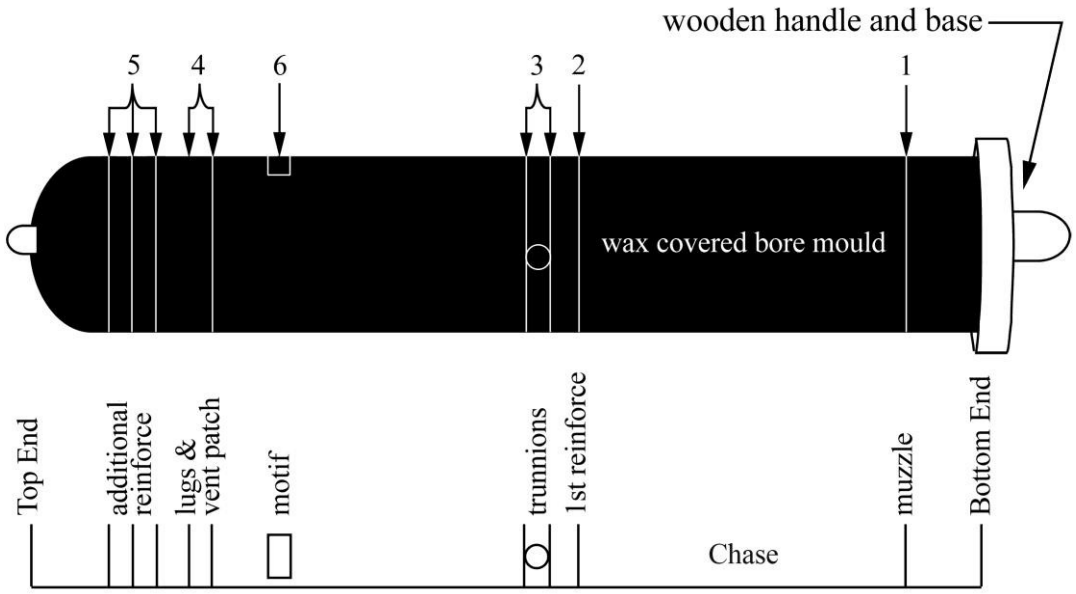


Figure 18. Bore mould assembly with wax coating, showing the feature positions marked with scored lines.

approximate mid-point of the bore mould;

Position (3) Trunnion marks, two score lines, spaced approximately 2 cm apart, and a circle incised between them, set immediately before the first reinforce line;

Position (4) Lugs and vent patch marks, two lines scored approximately 3 cm from the top of the mould.

Position (5) Additional reinforce marks, three lines incised at the appropriate locations;

Position (6) Motif mark, rectangle incised where the motif is to be placed.

After the guidelines are set, the craftsman continues rotating the mould on his lathe and pares the wax into the desired cannon shape. He begins with the muzzle end below position (1), which he carves with a small knife into the shape of a candelabra base. Next, he creates the chase by shaving approximately 2 cm of thickness from the wax between lines (1) and (2) using a wide flat-ended stick. He then builds up the lugs and vent patch with additional wax. For this he takes some

wax string, which he warms to make malleable and then shapes into three small rectangular cubes. One surface of the wax cubes is heated again briefly over a fire so that it will adhere to the mould wax. The craftsman presses each cube onto the mould wax at the proper locations at position (4), and then leaves them to harden for about five minutes. He then carves the cubes using a thumb knife to form the rectangular vent patch and two lugs to either side.

Moving on to the breech reinforce band, the worker reheats more wax string and applies it to the wax mould, encircling the mould along line marker (5). After being allowed to harden for about 10 minutes, the wax band is shaved down to the desired height and properly formed on the lathe.

Motif Creation

Particular motifs are applied using ready-made clay 'stamps' (Figure 19). The iconography used for this particular cannon was a simple flower design. The craftsman prepares the stamp by first rubbing fine sand onto its surface. This is to prevent the wax from adhering to the stamp, so that they can be separated easily without distorting the shape of the motif. Next, he prepares additional wax in the heated wok until it is the approximate consistency of soft butter. Using a small knife,

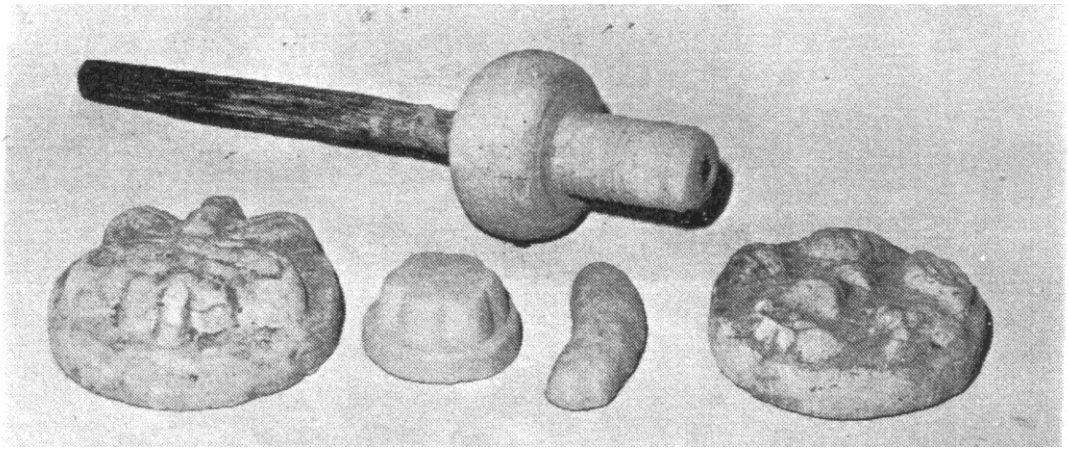


Figure 19. A wooden dowel with handle, along with several examples of clay motif stamps (from Lim and Shariffuddin 1985:157).

he spreads the soft wax evenly over the stamp, and then presses it carefully onto the mould at position (6), allowing to sit then for about ten minutes until it hardens and firmly adheres to the mould. The worker then removes the clay stamp by carefully pushing the sides of the stamp with the knife. The stamp separates from the mould and leaves behind the flower motive in wax.

Trunnion Creation

To form the trunnion moulds, the craftsman heats a stack of eight wax strings over a fire until they fuse together into one mass. He then rolls the wax back and forth, forming it into a cylinder. Once he has the desired shape, he inscribes two lines around the middle part of the cylinder. The space between the lines roughly delineates the width of the cannon's first reinforce. The worker then shaves down the wax between the lines, creating the access and what looks like a dumbbell (Figure 20.1). He heats the access and inner face of the two cylindrical ends over the

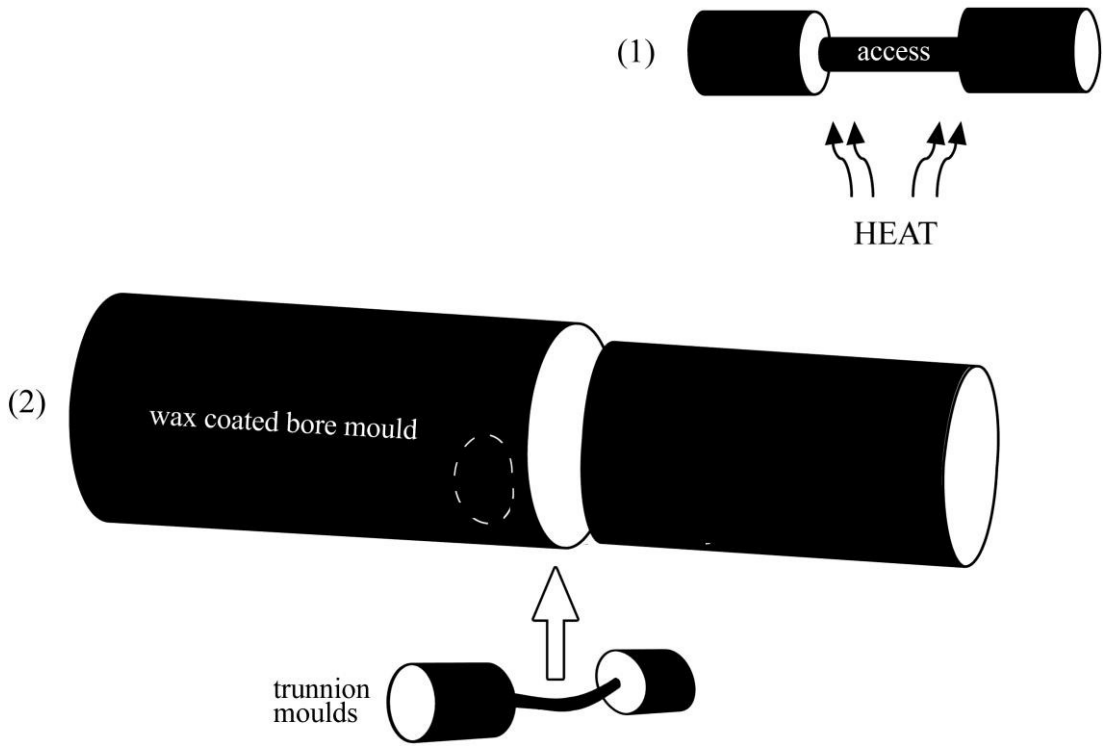


Figure 20. Trunnion creation.

fire to make them pliable and then immediately presses the ends onto the circular marks on the mould wax at position (3) (Figure 20.2). The joint is allowed to harden for about fifteen minutes, after which the worker shapes each trunnion mould using a thumb knife until they are the correct and identical size. The access is simply smoothed out and trimmed flush with the mould wax surface.

Wooden Dowel Removal and Sprues Creation

With the cannon mould now basically complete, the craftsman removes the wooden dowel simply by striking the protruding pointed end of the dowel stick with a hammer while his assistant slowly pulls and twists the handle. With only a couple of careful strikes, the dowel separates from the clay mould and slips out. The void space left behind is filled with fine sand.

The workers' next step is to attach four wax strings to the muzzle end of the mould while standing it upright. These will form four sprues, or channels, that allow evaporated wax and hot gasses to escape as molten brass is poured into the mould (Figure 21). When all is done, the wax-coated mould is set aside to dry for about an hour.

Model Mould

Once the essential cannon shape has been sculpted in wax over the bore mould, the outer model mould is created by covering the entirety in clay. Thus formed, the inner surface of the model mould will contour to the wax model and act as a negative of the desired cannon shape. The model mould is made from a similar clay mixture as the bore mould, but includes a greater amount of paddy husks. This helps to dissipate heat during the pour and keep the mould from cracking.

The worker first rubs fine sand over the entire surface of the wax coating to keep it from sticking to the mould clay. He then applies the clay mixture, pressing it onto

the wax with his hands and starting first with the two trunnion moulds, so as to prevent them from shifting. From these, he continues applying clay over the entire length of the model.

Next he turns to the muzzle face. Here, he first supports the sprues by building up clay around each one of the standing wax strings and then filling in the spaces between, but only around the circumference. The craftsman leaves the central portion of this end open and works the surrounding clay into a funnel shape. It is via this 'funnel' that he will later introduce the molten bronze into the mould. With this completed, the entire wax model is encased in clay. Only a centimetre or less of the wax sprues is left protruding from the end of the mould, so as to maintain clear openings for the vents.

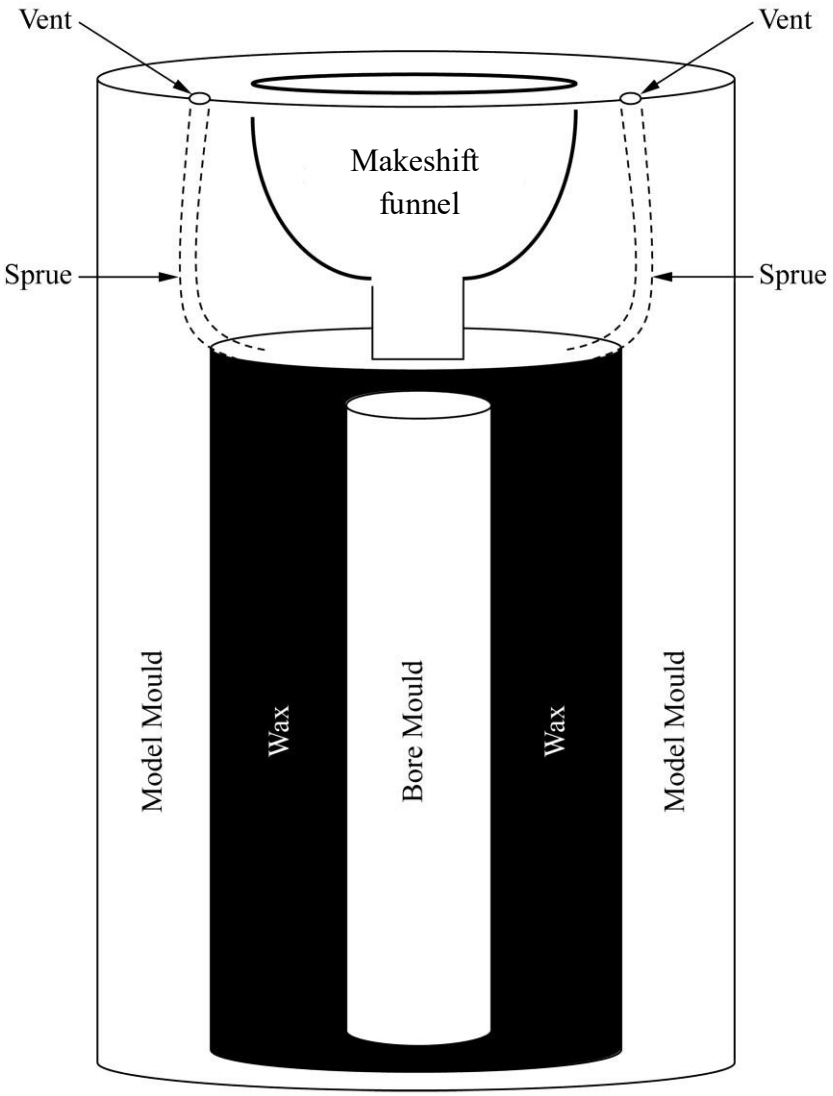


Figure 21. Makeshift funnel, sprues and vents.

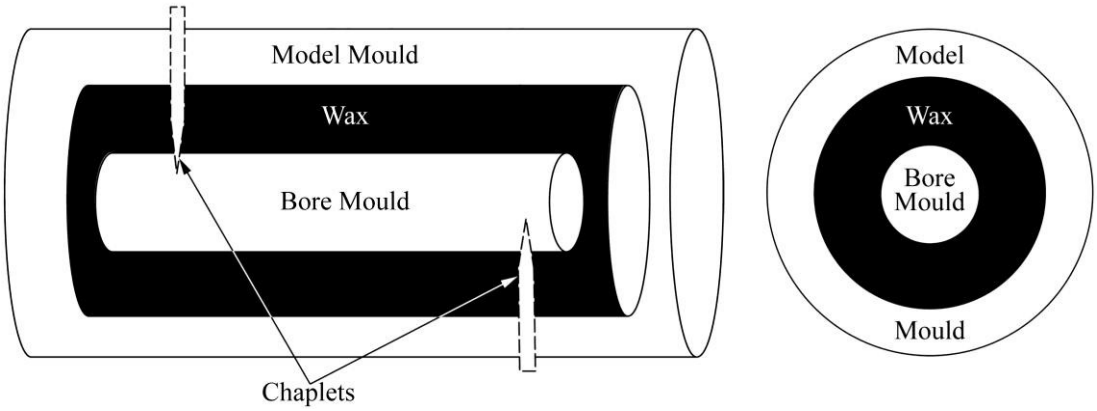


Figure 22. Model mould and chaplet application.

For the final step, the cannon maker hammers in four bronze spikes, or chaplets.[5] Two chaplets are driven into the chase section of the cannon, while the other two are set along the first reinforce. The chaplets will hold the bore mould in place during the pouring process, when the wax vaporises (Figure 22). The mould is then left to dry for three days in a protected area.

Crucibles

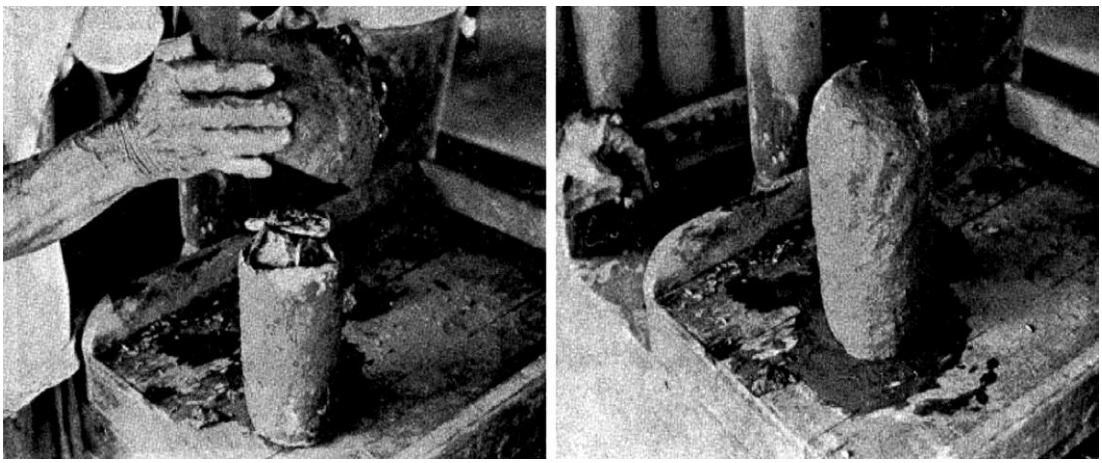


Figure 23. Crucible creation (from Lim and Shariffuddin 1976:158–159).

While waiting for the model mould to dry, the caster begins making the crucibles he will use to melt and pour the metal for the cannon (Figure 23). He makes four crucibles using a mixture of clay, charcoal and paddy husks. Sand is spread over the interior of each one to prevent it from cracking when it comes into contact with moisture. There does not seem to be any standard 'formula' followed in making the crucibles, the caster simply relies on his experience. The only real requirements are that the crucibles are large enough for the amount of metal to be poured (in this case, less than two litres per crucible) and that they are able to withstand the high temperatures of the heating process and molten metal. The top of each crucible is punctured with a small knife to make the outlets from which the molten bronze will

[5] The chaplets were made beforehand, unobserved by the author, so no specifics about them can be illuminated here.

be poured. The formed crucibles are left to dry for two days before they are used.

The crucibles can be used only once, since metal residues and possibly other impurities remain inside the vessels after use. As explained by Awang Haji Suhaili Haji Untak (personal communication 2012), these residue deposits can adulterate subsequent bronze mixtures melted in the crucibles and alter their properties, such as melting point and hardness.

Heating

Two furnaces are used to heat the crucibles and melt the casting metal, and to vaporise the wax from inside the cannon mould. They are fired with the aid of piston-type bellows known as 'Malay Bellows' (Figure 24). These devices force air into the furnaces, providing additional oxygen for combustion and raising the heat output until the furnaces are hot enough to melt bronze. The type is said to have been used for "at least a thousand years" (Reid 1988:112–114). Although this cannot be considered a precise date, it does provide an indication of the great antiquity of the bellows. Indeed, piston bellows in the East are thought to be an innovation of the Malay peoples of Southeast Asia (Needham 1965:140–141).

The two furnaces are makeshift oval dug-outs, each about a metre deep. Each furnace has two bellows attached to one end. Traditionally, the bellow cylinders were made from bamboo. The bellow pistons are metal poles with a mass of leaves bonded with wax at one end. The air forced out from the bellows is directed to the furnace through tuyeres. Two bellows are employed, so that a steady flow of air—and, thus, constant heat—is maintained, with one bellow supplying air to the furnace while the other retracts and pulls in fresh air for the next stroke.

When the furnaces are sufficiently hot, the mould is positioned carefully in the

Figure 24. Worker operating two Malay bellows (from Lim and Shariffuddin 1985:160).

first, with the muzzle end up and the breech end placed against the base of the furnace. The crucibles are placed in the other furnace once its temperature reaches at least 1083 ºC, the temperature required to melt bronze (Lim and Shafiffuddin 1976:146). The crucibles and the mould are then partially buried in their respective furnaces and left to 'cook' for two to three hours, while the workers continue to pump the bellows.

Casting

After the allotted time, the model mould is removed from the furnace using long wooden tongs. The worker turns it upside down and pours out any remaining liquid wax. The caster then removes the first of the crucibles, full now of molten bronze. He pours the liquid metal into the funnel of the model mould until it overflows slightly, all the while carefully shaking the mould to ensure that the liquid fills all parts of the mould and no voids remain. Satisfied with the pour, the caster then

stands the casting in a sand-filled pit. He wraps metal mesh around the exterior of the mould and covers it entirely with clay, including the exposed funnel end filled with metal. The mesh and clay provide additional support and keep the molten bronze from shifting or floating as it cools and hardens. They probably also serve to insulate the mould and keep the cast from cooling too quickly and shrinking. At the bottom breech end, the caster fashions a 'toe' (much like the base of an amphora) with the added clay, which helps the cannon mould and cast stand upright in the sand as they cool.

This orientation is purposeful, as it helps ensure that the molten metal fills all void spaces towards the lower end of the mould, namely, in the breech and reinforce part of the cannon. The weight of the overlying molten metal also helps maintain a denser and stronger cast as the metal cools in this critical end of the cannon, where it must withstand the full force of the detonation (Guilmartin 1974:291). Correspondingly, this might explain as well why cannon muzzles are made larger and thicker, in order to compensate for this inherent disadvantage of being at the top of the cast, and thus less dense and weaker.

Polishing

Once the cast metal has completely cooled and hardened, the cannon maker simply breaks the moulds with hammer and chisel to remove the cannon. At this point, the gun surface is quite rough, with visible impressions and guidelines left from the wax coating process and sprue metal and chaplets protruding. The craftsman pulls out the chaplets with pliers, and patches the holes left behind with some of the same bronze used for the cannon. He hammers a small piece of malleable bronze into the hole, a process similarly used to conceal, reinforce, or repair other voids or worn areas (Figure 25) (Oron 2001:24). If a chaplet cannot be

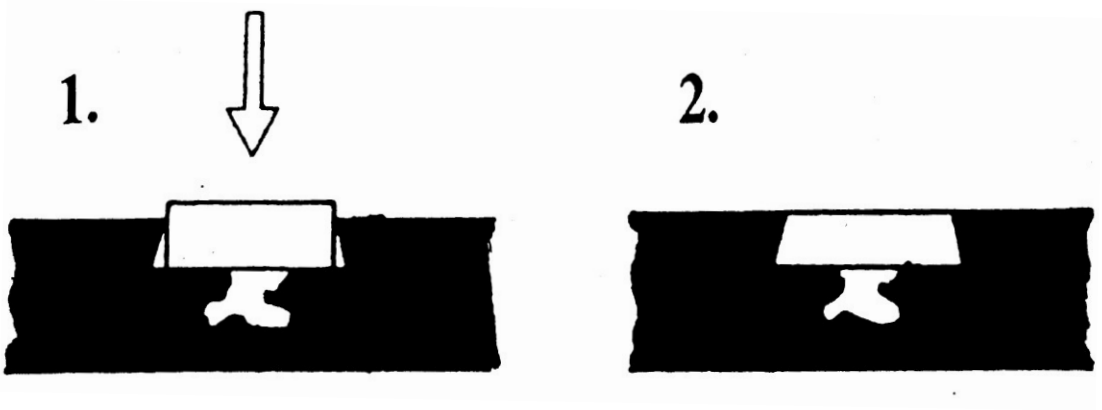


Figure 25. Patching application (from Oron 2001:25).

removed completely, or is fused to the cannon, it is cut down close to the cannon surface and filed flush.

The entire rough surface and any ridges, chaplet marks, patches or other imperfections are ground down with an iron file and sanded smooth with a fine-grain sand paper, a result of which the polished metal surface turns golden brown in colour. In the final step, the gun maker departs from traditional methods and uses a modern electric drill to fashion the cannon's vent. With this, the cannon is completed (Figure 26).

Figure 26. Examples of modern miniature cannon.

Summary of Observation

A number of observations made during this process may prove useful for identifying cannon casting and explaining the bore moulds that are employed. The

cannon casting method practiced in Brunei is a version of 'lost-wax' casting. This method has been used in Southeast Asia since at least the Bronze Age (Higham 1996:171–175). Lost-wax casting is known to be versatile in making divers types of objects, from small trinkets to large and more intricate sculptures, such as bells, spears points, axe heads and even Buddha statues (Andaya 1992:39; Laichen 2003:497–510). Weapons made by lost-wax casting testify to the method's applicability to objects that must be strong and durable, able to keep a honed edge. Similar characteristics are important for cannon, which must endure the stress and pressures of explosion and accelerating shot. However, more convincing testimony in this regard is the ancient Mediterranean bronze warship ram, such as the Athlit Ram, which also was made by lost-wax casting (Oron 2001:1–3). As a massive naval weapon fitted to the prow of a ship, it was designed to smash enemy ships, transferring the full momentum and force of impact from the ramming vessel to the hull of the rammed ship, smashing it open in the process. Clearly, the cast metal needed to be strong and durable, and capable of withstanding terrific force.

The observed cannon casting process demonstrates several key points regarding gun founding:

- The technique of boring is not known in Brunei, and the caster himself had never heard of it (Awang Haji Suhaili bin Haji Untak, personal communication 2012). Instead, the cannon maker breaks apart the clay bore mould to remove it from the cannon, and smooths the bore manually using a scraper and chisel.
- Comparing the archaeological evidence and observed cannon making, the mixture of clay and paddy husks used to make the bore mould and crucibles appears to be consistent, demonstrating a continuity of tradition.

- Similarly, *damar* continues to be used and still is easily obtained throughout the region.
- The specific clay used has a direct correlation to the quality of the mould and the cannon cast in it; the finer the clay, the fewer the cavities or other imperfections in the cannon.
- The guidelines and position markers inscribed in the wax model leave a permanent imprint on the cannon, but are sanded smooth or covered over by decorations so that they are no longer visible to the naked eye.
- Malay bellows are considered an early innovation of furnace technology, but precise provenance and dating still require confirmation. In any case, the bellows and simple furnace are effective for bronze melting, can be set up quickly, and can be reburied once the casting is completed.
- Chaplets are used to hold the bore mould in place during the pour, thus supporting Green's (2006:10) speculation on the use of metal bar chaplets rather than Wignall's ringed crown pieces.
- The patching technique observed in this session were used to fill in the chaplet holes, but it is reasonable to assume that the same technique could be used in covering general imperfection as well.
- Theoretically, the positioning of the trunnions slightly below the centreline of the bore could simply be a continued practice, although some scholars suggest that it was adopted from sixteenth-century European convention (Davie 2009; Saunder 1982:71).

There are several aspects of the process (apart from the use of modern tools and recycled scrap metal) and omitted steps that should be addressed here:

- The cannon maker did not cast the yoke or tubular cascable during the

demonstration, indicating that these parts are created separately after the cannon body is completed. According to the caster, when making the yoke, he first forms the socket moulds by pressing clay onto each trunnion to ensure proper fits, and then casts the socket using the lost-wax method. Next, he moulds the arms and rest of the yoke to the socket exteriors and casts them in the same way.

- Quartz was identified in the bore mould artefacts, but was not used in the casting demonstration. It is still not known what role quartz may have had in the casting process, but it does suggest that there have been changes in the raw materials used in Brunei cannon manufacturing over the centuries.
- The cannon cast for the demonstration was less than 70 cm long and required only a single pour. Larger guns typically are made in several sections (e.g., chase and first reinforce) requiring multiple pours (Awang Haji Suhaili Haji Untak, personal communication 2012).
- The type of cannon cast for the demonstration is for decoration purposes only, and so standard measurements are not applicable.

As a final note, it was telling to observe the removal of the cast cannon from its mould. This was done simply by smashing the exterior clay model mould, and then breaking up the bore mould clay with hammer and chisel and using a scrapper to remove what remains. Thus, the bore moulds excavated from Kota Batu and Pulau Terindak were never used in an actual cast. Furthermore, since they have traces of *damar* on their surface, they probably were abandoned early in the wax coating step, although for what reason we will never know.

CHAPTER 8
SEVEN CANNONS

This chapter examines seven cannon from the Brunei Museum, arranged in chronological order by the year each was accessioned into the collection. The description of each cannon includes their design elements, parts and features and evidence of casting (see Appendices 3 and 4 for cannon and motif terminologies). When recording the cannon, special attention was given to detecting evidence for:

- component materials, especially through visual examination and magnetic testing of the metal;
- the casting method, especially telltale signs such as guidelines, chaplet marks and mould impressions;
- casting flaws;
- foreign influences in design or functional elements;
- and firing.

All key dimensions were recorded (see Appendix 5 for complete cannon measurements) and the Harrisson ratio for each gun was calculated from its overall length and bore diameter.

In general these cannons have received minimal conservation treatment, typical of early archaeological practice (Bowen 2006:201; Wignall 1973:92). They have been cleaned and their surfaces smoothed, both inside and out. None of the cannon had any documentation, nor had any been subjected to research into their provenance, history or manufacture.

Cannon 1966-219

Type: *bedil buloh*

Overall length: 124.0 cm[6] Category: 91–150 cm category

Bore diameter: 3.4 cm Weight: 31.0 Kg

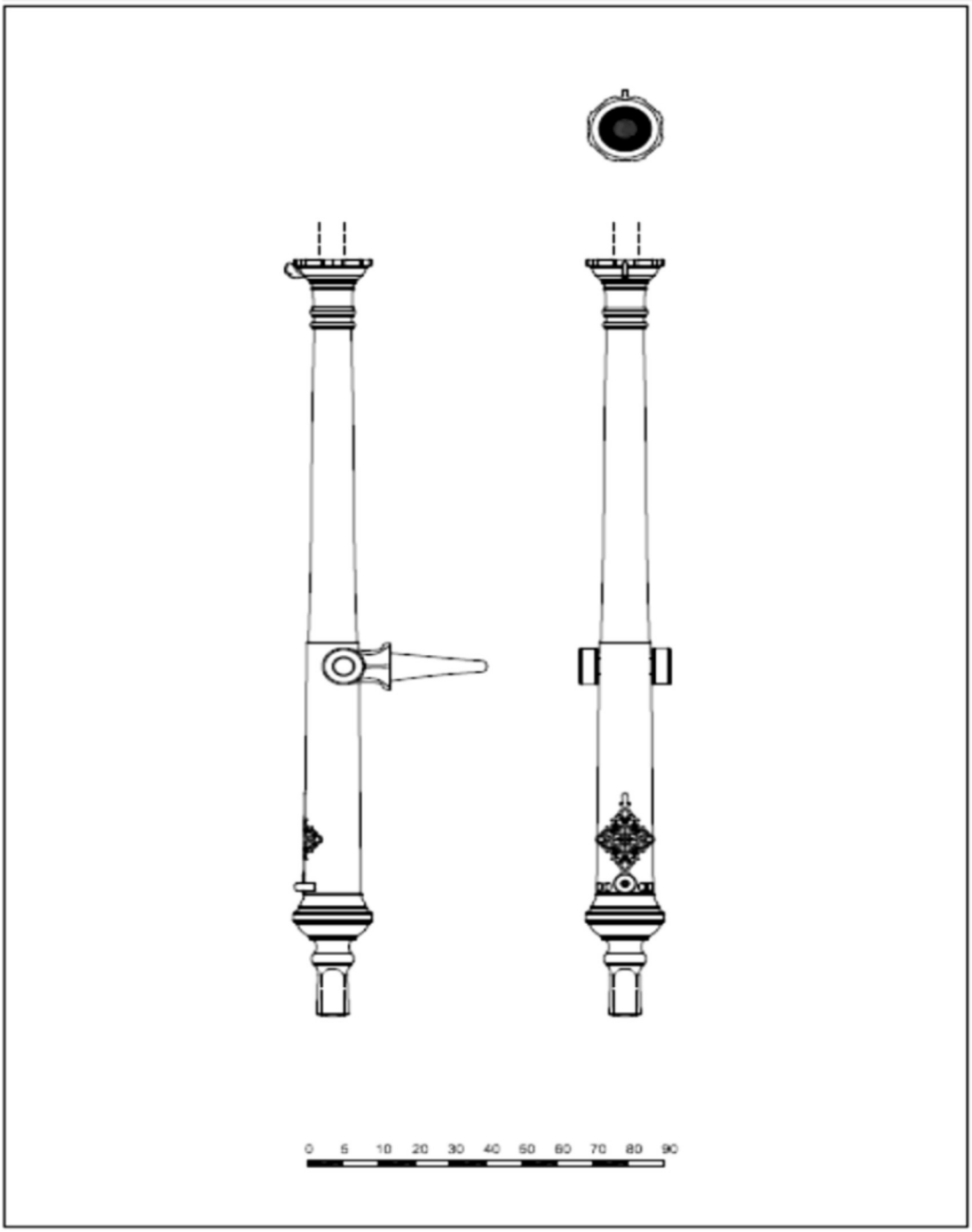


Figure 27. Drawing of cannon 1966-219.

[6] Bulat (2006:107) gives a length of 124.2 cm.

Cannon 1966-219 is a *bedil buloh*, based on its smooth overall finish (Figure 27). Corrosion is visible on the lower parts of the neck and muzzle, while the metal of the lugs and lower part of the chase has a yellowish-golden tint. None of the cannon was magnetic. The visible areas of golden colour may suggest that the cannon was cast from *tembaga*, but elemental analysis is required to determine the true nature of the metal.

The cannon has a tubular cascable, or *gaganok*. The breech reinforce consists of seven bands varying in thickness from 2 to 10 mm. The vent is located on a decorated circular patch with a lug to either side. This "vent patch" feature first appeared in the early eighteenth century (Blackmore 1976:248), providing a *terminus post quem* for the cannon. The lugs have no holes for the cover, and probably are decorative only. The top of the reinforce is decorated immediately above the vent with a rhombus-shaped leaf pattern (*daun lukut*).

Cannon 1966-219 has several features that hint at a possible Spanish or Portuguese influence. The first is the step feature, or *tangga*, where the gun diameter steps down at the juncture of the first reinforce and chase. The decrease in diameter is 2 mm. The other features are the positions of the two reinforcing bands on the neck and the cannon's flat octagonal muzzle (Hoskin 2006:67; Guilmartin 1974:160). These features are typical of Spanish and Portuguese cannon, although not necessarily of swivel guns *per se*.

Three features indicate that this cannon was made by lost-wax casting. The first, and perhaps most obvious, is the misshaped muzzle (Figure 28). It appears that the cannon maker encountered a problem when pouring of the molten bronze into the cannon mould. The makeshift funnel seems to have collapsed, or at least been depressed by the molten metal, leaving the inner muzzle face distorted.

The second feature is a series of lines (shallow depressions) encircling the body of the cannon (Figure 29). All of the lines on the barrel are parallel to one another, and the lines on the trunnions are perfectly aligned. Clearly, these are not flaws, but rather position markers for the various cannon features inscribed into the wax model before casting, as described in the previous chapter.

Figure 28. Muzzle of cannon 1966-219.

Figure 29. Circumscribed lines on cannon 1966-219.

Figure 30. Traces of hand moulding on right arm yoke to the socket.

The third sign pointing to lost-wax casting is the traces of hand moulding on the non-clasped yoke (Figure 30). These telltale signs show where the cannon maker attached the yoke arms to the sockets, which would have been moulded and cast first (as described above by Awang Haji Suhaili bin Haji Untak). The overall appearance of the yoke and cannon body is the same, indicating that they were made in the same manner. Thus, even though the two elements were created separately, these traces, especially in conjunction with the other evidence, confirm the method of casting.

Cannon 1966-366B

Type: *bedil buloh* (HD)

Overall length: 121.0 cm[7] Category: 91–150 cm category

Bore diameter: 3.4 cm Weight: 31.3 Kg

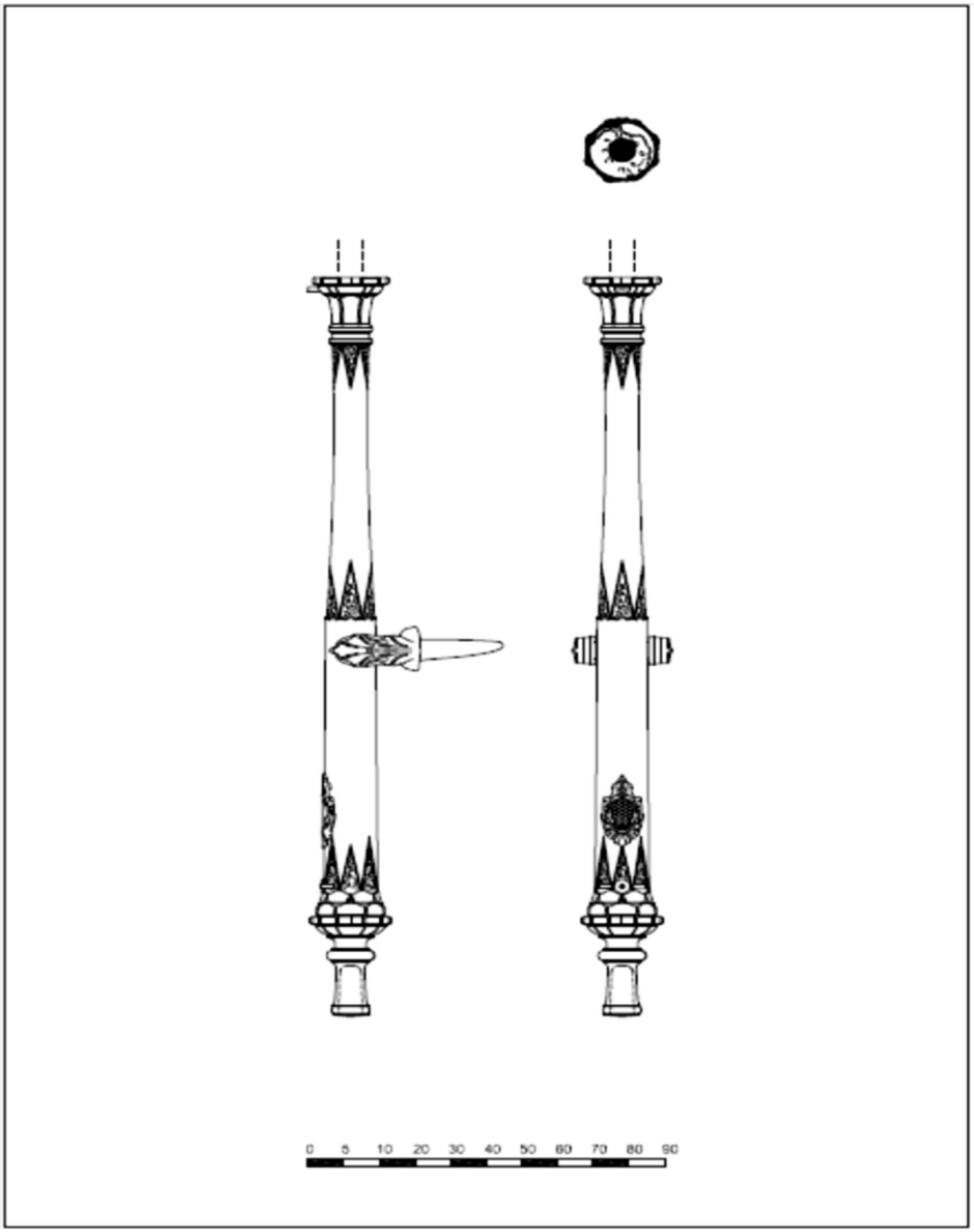


Figure 31. Drawing of cannon 1966-366B.

[7] Bulat (2006:111) gives a length of 120.1 cm.

Cannon 1966-366B is a *bedil buloh* (HD), based on its multiple different decorative elements. As seen in Figure 31, it has a tubular *gagnok* cascabel and a combination of four design elements elaborating the breech and reinforce: a *bunga matahari* type base ring with eight protrusions, a decorative frieze consisting of forward-pointing elongated triangles (*pucuk rebung*) filled with leafy vine designs (*bunga menjalar*) encircling the reinforce just above the breech, and a large *daun suganda* leaf medallion with a central field of tortoise-shell motif (*sisik penyu*). *Pucuk rebung* friezes decorate the two ends of the chase, one immediately following the step from the reinforce, and the other, inverted so that the triangles point toward the breech, immediately preceding the first muzzle astragal and fillets (Figure 31).

The vent is located within a circular vent field in between two decorative lugs. The cannon also has a highly ornate yoke collar, decorated with a leaf design (*daun sunganda*) and circular tortoise-shell motif (*sisik penyu*). The cannon has a second muzzle astragal and fillets reinforcing band, and its neck is decorated with mantis shrimp finger (*jari satak*) motifs. Like the base ring, the flat muzzle is a *bunga matahari* ring with eight protrusions and a half-leaf motif (*daun setampik*) above it as a sight.

Besides its decoration, this cannon has many casting flaws, which, in turn, demonstrate how the gun was made. One of the most telling signs is the uneven surface on the muzzle face (Figure 32). This ‘layering’ effect is a clear indication of poor casting of the molten bronze in the makeshift funnel of the model mould. This may have resulted from additional molten bronze being poured after the initial pour had already begun to cool. The eight small lumps on the muzzle face show where the sprue vents were located and then patched after the cannon was cast. The caster clearly did not bother to file the patches down and polish them smooth.

Figure 32. Uneven layer and the eight bulbs on the muzzle face.

Other attributes indicative of casting are the rectangular chaplet mark on the chase of the cannon. The surface of the cannon surrounding the marks has an orange-rust coloured tint, hinting that iron chaplets had been used (Figure 33). This, though, could not be supported by magnetic test or other means.

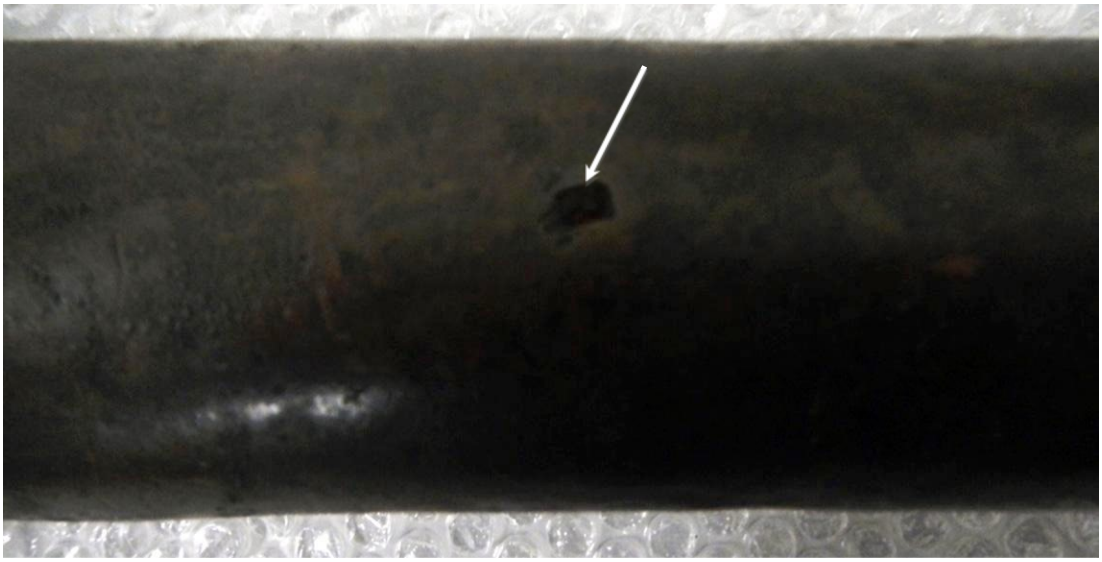


Figure 33. Chaplet mark on the chase.

Figure 34. Longitudinal lines on the first reinforce.

Of special not are four longitudinal lines running the length of the first reinforce (Figure 34). Unlike position markers, these lines have a small gap between them (a needle was inserted into the gaps during recording). This demonstrates that the first reinforce was made using a different, or composite, method that included an additional step after the initial casting.

The first reinforce of this cannon is 4 mm larger in diameter than the chase, meaning there is a 2 mm 'step' down from the one to the other, respectively. From the observed construction features, it can be deduced that the cascabel and reinforce were lost-wax cast in one piece of constant diameter. The gun maker then 'built up' the reinforce by forging four strips of copper sheeting, each roughly 2 mm thick, onto the reinforce. The forging fused the strips to the cannon body and to each other to create the final reinforce. The *bunga matahari* ring on the collar may, then, have acted as a fastener of sorts (much like a barrel strap) to strengthen this assembly.

Accordingly, this cannon was probably cast in a technique similar to what Marsden (1811) describes, with the combination of Green's (2006) chaplets used in its casting. A nearly identical technique of manufacture was practiced in Europe, and

two such composite cannon were recovered from the Dutch VOC *Batavia* shipwreck off the coast of Western Australia (Green 1989:37–45). The outer layer of these cannon consists of copper sheets rolled and forged to the main cannon body.

Cannon 1966-840

Type: *bedil gargabus*

Overall length: 148.0 cm

Category: 91–150 cm category

Bore diameter: 10.0 cm

Weight: N/A

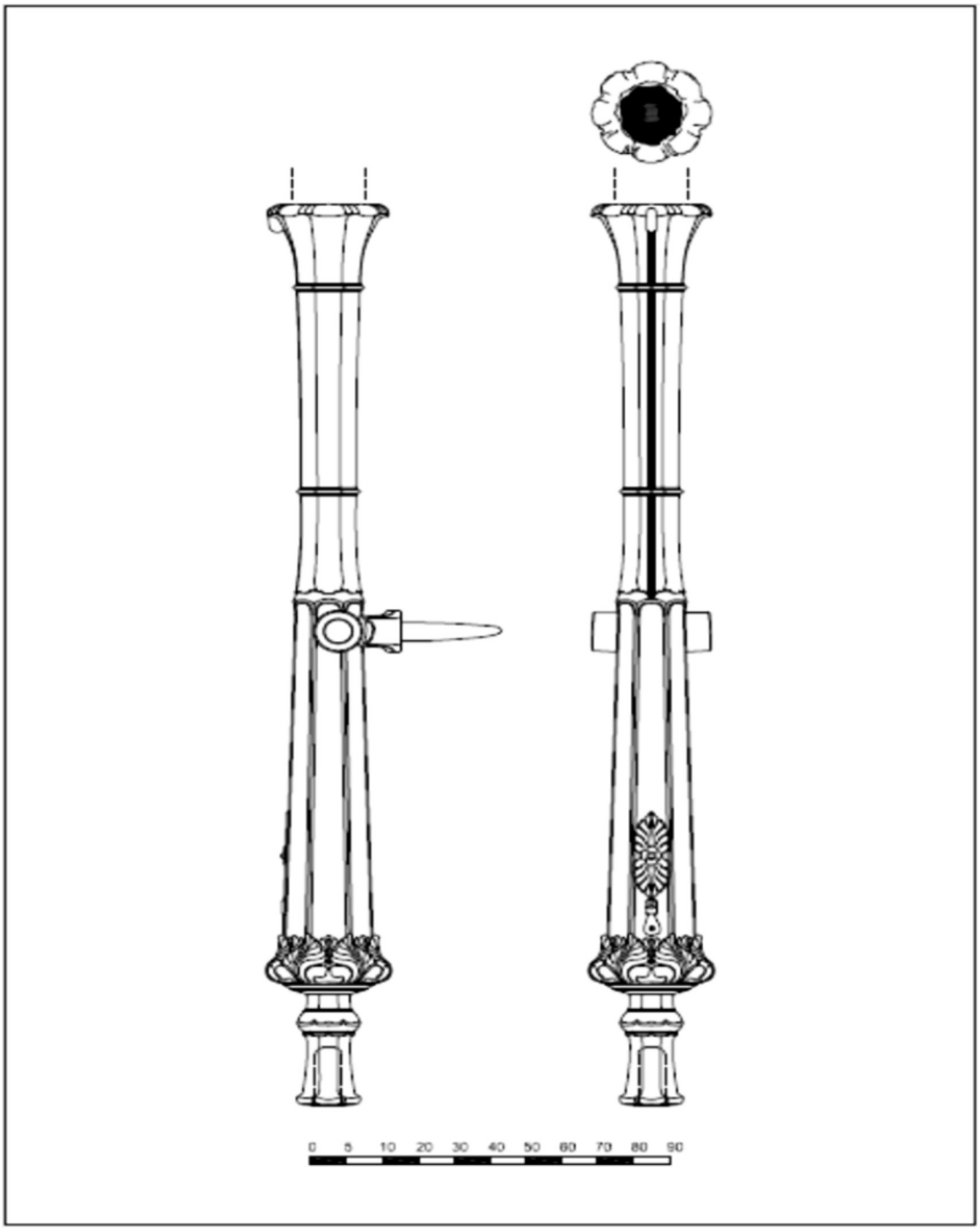


Figure 35. Drawing of cannon 1966-840.

Cannon 1966-840 is a *bedil gargabus*, the only one recorded in this study and one of the cannon for which no documentation exists (Figure 35). The cannon's body has an octagonal cross-section, as does its tubuluar cascable. The breech reinforce is decorated with eight leaf motifs (*daun lukut*), arranged such that the edge of each body facet projects from a leaf tip.

The vent is located in a teardrop shaped vent field which, based on its smooth appearance, has recently been clean. Immediately in front of the vent is a lug attached to a *daun lukut* motif, consisting of a raised floral element centred between opposing leafs. The raised flower also may have functioned as a sight.

The chase of this cannon has two reinforce bands, located roughly equidistance from the chase girdle and muzzle, respectively. These ring-bands are connected to a longitudinal band that runs along the top of the chase from girdle to muzzle sight, forming a sort of 'cage' reinforcing element (Figure 36). This type of reinforce band is an interesting oddity, as it is uncommon in the collection. It also has a generally

Figure 36. The reinforcing "cage".

weaker appearance than the more conventional reinforce bands. However, it has been suggested that an octagonal body is stronger, lighter and more durable than a

cylindrical body (Hoskins 2003:27). Furthermore, Shariffuddin (1969:89) suggests that this type of cannon is used only for firing "small stuff" and for signalling. Gerald Gardner (1936:95) concurs, considering it a close-range weapon used to fire slugs and stones. Compared to firing solid shot, this would require a less powerful blast and would be less stressful on the cannon. Based on this example and at least five other *gargabus* cannon (such as Cannon 1967-310A and 1967-310B), all of which have lighter muzzle reinforce bands, this type of gun had little need for reinforcing elements (Bulat 2006:133).

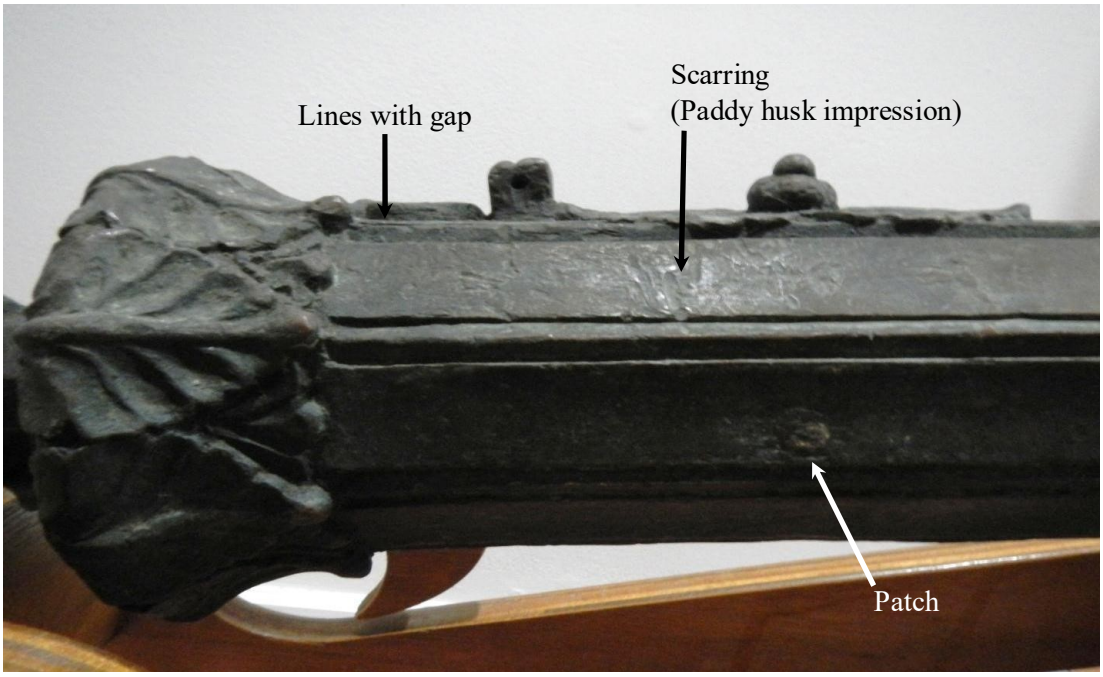


Figure 37. Patching and probable paddy husk impressions on the first reinforce.

Beyond this, little can be said towards its casting method. Awang Haji Suhaili bin Haji Untak (personal communication 2012) certainly believes it was lost-wax cast, explaining that the "scarring" marks near the breech are paddy husk impressions from the clay model mould (Figure 37). This results when the mould clay is not mixed sufficiently and husk material clumps together. Although the molten metal would completely burn away the organic material, its impression in the

clay mould would still leave the corresponding marks on the cannon.

Besides these mould impressions, the first reinforce has longitudinal lines with intermediate gap indicating that this cannon was made in the same manner as cannon 1966-366B, that is, by forging individual bronze strips onto the cast body (Figure 38). There also is a typical circular hammered patch on the reinforce, which may have repaired a tear or weak (thin) spot in that particular bronze strip (Figure 37).

Cannon 1969-36

Type: *meriam*

Overall length: 137 cm[8] Category: 91–150 cm category

Bore diameter: 6 cm Weigh: 116.80 Kg

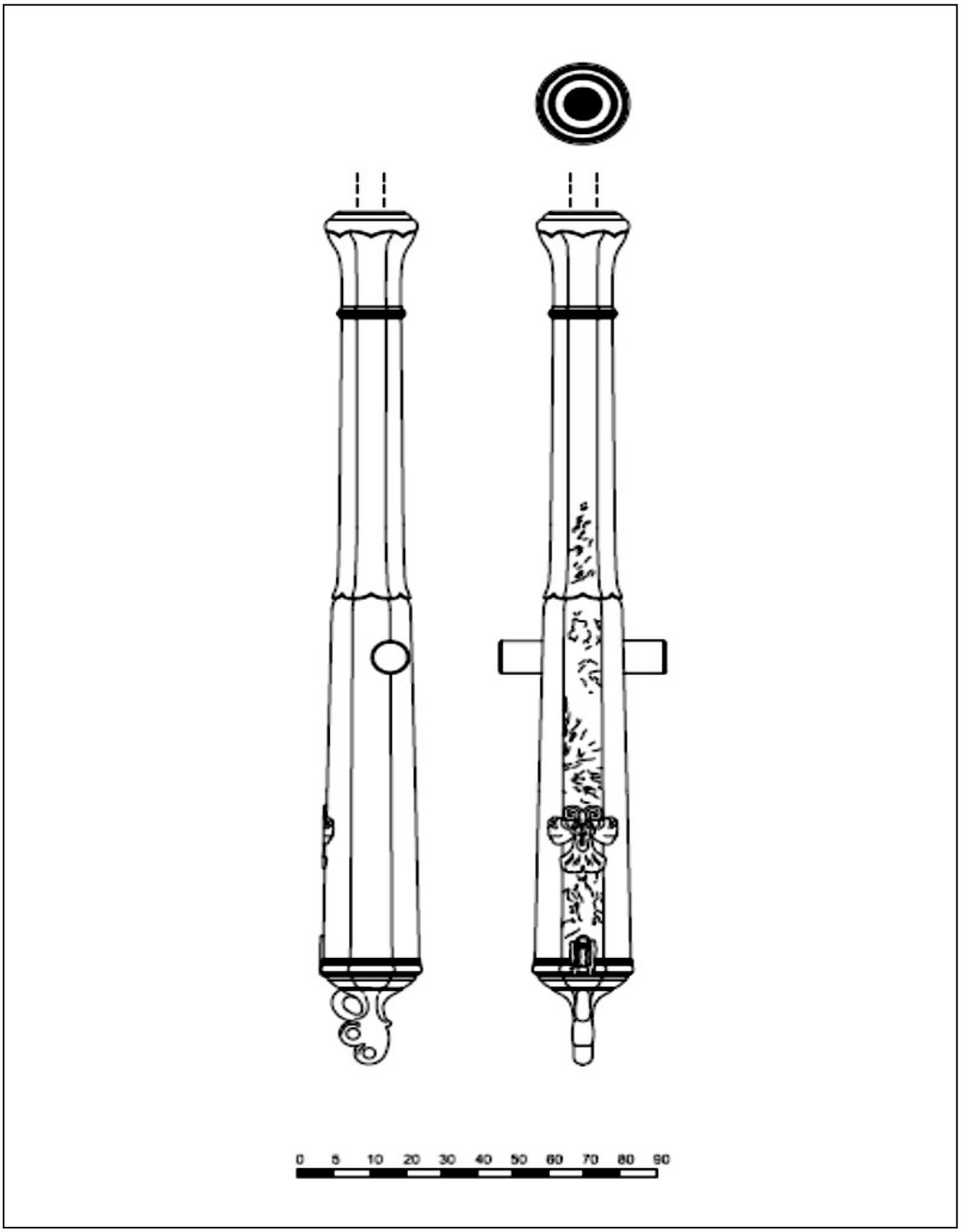


Figure 38. Drawing of cannon 1969-36.

[8] Previously recorded as 129 cm (Bulat 2006:147).

Cannon 1969-36, currently on public displayed in the Brunei Museum, is a *meriam* type cannon with octagonal body cross-section (Figure 38). The cannon is fitted onto a carriage, but one that was added later and is probably not of the proper type. This is evidence from the fact that the gun's trunnions do not sit properly in the carriage clamps.

The gun's cascable is shaped like a rooster's crown, when viewed from the side. This is not a conventional feature to either Southeast Asian or European cannon. No cannon in the Brunei Museum collection shares this feature, nor was any parallel found in the literature cited in this thesis. In any case, this is not a unique situation, as some cannon have a cascabel shaped like a lion's head, and the cannon *Si Jagur* has a cascable that depicts a rather vulgar hand gesture (Figure 39). Such singular features probably are attributable to individual gun makers, and their particular fancies, rather than to any regional convention.

The vent opens within a rectangle vent field, which shows signs of having been cleaned recently. There is no cover. The cannon has two lugs, which are unique to the collection. They are flat and placed on the breech end of the cannon's base ring.

Above the vent is a large butterfly decorative motif called *kulimambang* or *kupu-kupu*. There are only fifteen other cannon in the entire collection that bear this motif. It is possible that this is a maker's mark, but so far there is no evidence to link the design to any particular founder. Beginning just above the vent and extending the length of the reinforce and onto the chase, the top of the cannon is marked by numerous cuts and scarring (Figure 40).

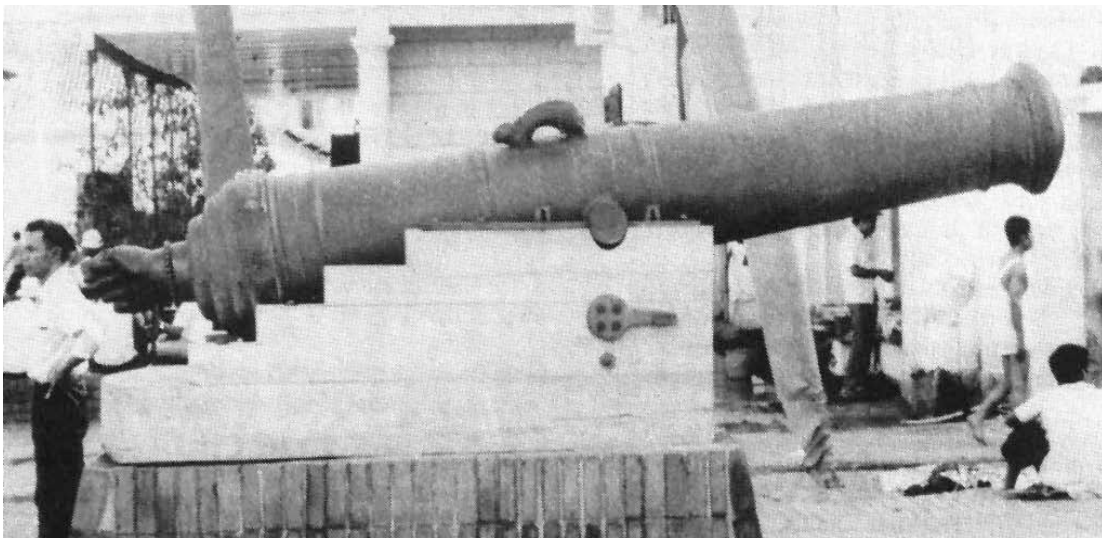


Figure 39. "Si Jaggur" (from Green 2006:9).

Figure 40. Cut marks on cannon 1969-36.

Figure 41. Flower bud reinforcement on cannon 1969-36.

At the forward end of the reinforce, the cannon body swages down in diameter and joins the chase in an unusual arrangement. Rather than being connected with a conventional reinforce ring, the reinforce fits into the chase in a kind of socket, shaped like a flower bud (Figure 41). A similar feature is seen also on a cannon called *Boom*, of known Brunei origin (Figure 42) (Shariffuddin 1969:84). This method of joining the two parts of the cannon body seems, from appearances only, to be a weaker join than the reinforce band, and could indicate that these guns are for decorative purpose only, rather than true weapons. The common joining method also may suggest that the two guns were made by the same nineteenth century caster, namely Pengiran Muda Binjai.

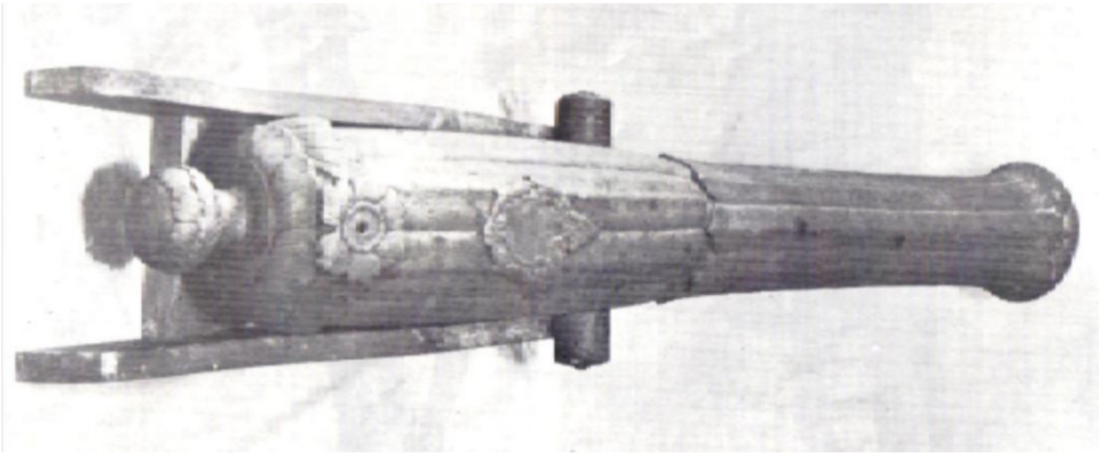


Figure 42. Flower bud reinforcement on *Boom* (from Shariffuddin 1969:84).

On the muzzle neck, there is an astragal and fillet type reinforce band. Rather than a flat muzzle, the cannon's muzzle has moulding consisting of a fillet and lip. This design is atypical of Southeast Asian cannon in the collection. The cannon appears to be of a more European design, rather than Southeast Asian, and could be a type of falcon or falconet (Mauncy 1985:34; Lavery 1987:103).

The cannon is black in colour, making it difficult to comment on its material of construction. However, traces of greenish corrosion products, especially on the

muzzle, indicate that the cannon is made from some copper alloy, and the dark colour could be the result of bronze disease suffered after it was removed from the Brunei riverbank (Wignall 1973:94). A negative magnetic test confirmed that the gun is not iron, and so must be some sort of bronze or brass alloy.

Cannon 1973-9

Type: *bedil buloh*

Overall length: 78.0 cm[9] Category: 61–90 cm category

Bore diameter: 2.3 cm Weight: 12.84 Kg

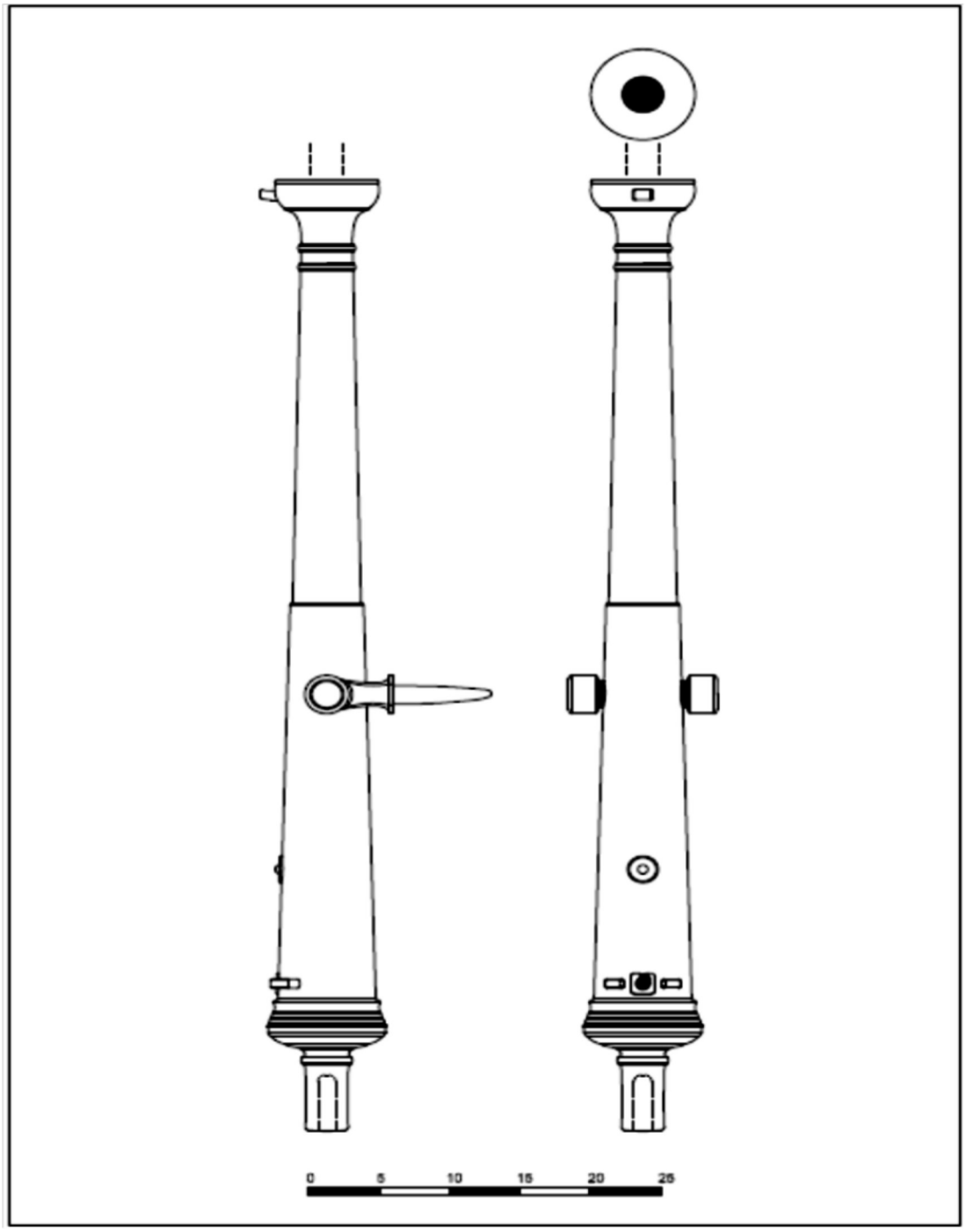


Figure 43. Drawing of cannon 1973-9.

[9] Bulat (2006:80) gives a length of 78.6 cm

Cannon 1973-9 is a *bedil buloh* and the smallest cannon in this study (Figure 43). The gun currently is kept in museum storage. It has a *gaganok*-type cascabel. The vent is located in a square field, one side of which is broken. A lug is situated on either side of the vent, but there is no cover. A sight modelled as a circular bulb is located towards the middle of the reinforce. The cannon body has a simple step feature where the reinforce and chase meet, and there are two reinforce bands located close together before the swell of the muzzle. The muzzle is large and circular, with a flat forward face, and has a sight mounted on it. The cannon has splotches of copper colour and greenish patina (Figure 44), and is non-magnetic, indicating that it is made from some type of copper alloy metal.

The cannon has few obvious design or manufacturing flaws. However, through closer examination (using a magnifying glass), a number of smooth circumferential 'lines' can be seen (Figure 44). Two such lines near the base ring align with the lugs, and probably represent position markers inscribed on the wax model. Other lines or facets detected seem to have been caused by uneven smoothing of the wax coating on the bore mould. Hence, it is likely that the cannon was made by lost-wax casting.

Figure 44. Positioning marks aligned with the lugs and vent patch.

Figure 45. Traces of moulding on the yoke mount, where the arms and sockets were joined.

The cannon's yoke mount is a non-clasp type and shows traces of moulding on its arms (Figure 45). The yoke appears to have been cast in the same manner as described above, with sockets first sized to the cannon trunnions and cast, and then the arms cast and joined to the sockets.

Cannon 1974-66

Type: *Meriam*

Overall length: 137.0 cm[10] Category: 91–150 cm category

Bore diameter: 6.0 cm Weight: 128.68 Kg

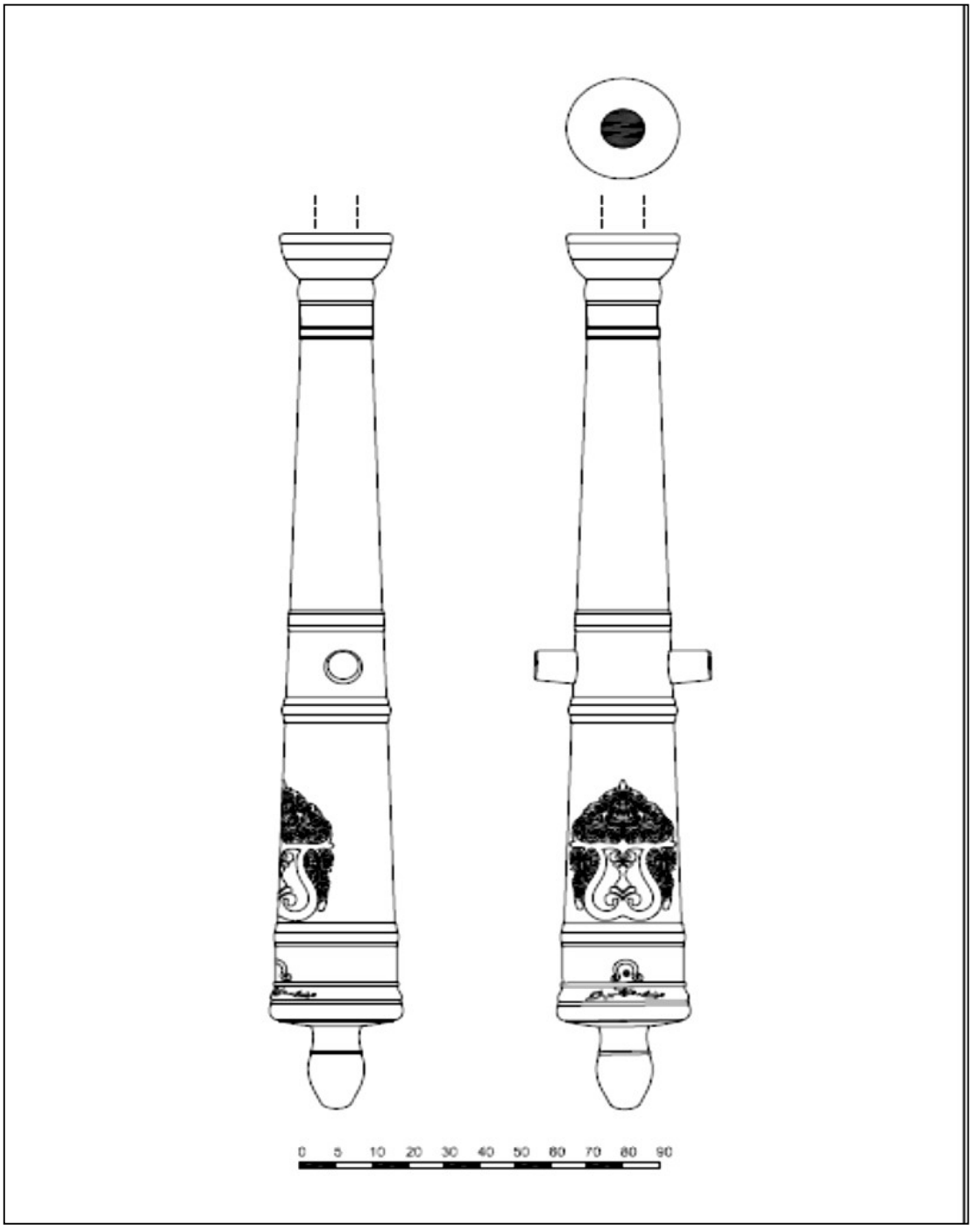


Figure 46. Drawing of cannon 1974-66.

[10] Bulat (2006:165) gives a length of 138.4 cm.

Gun 1874-66 is a *meriam*-type cannon. At present it is exhibited inside the Brunei Museum gallery opposite and facing cannon 1966-36 (Figure 46). The cannon has an overall appearance of European design. The cascable has a solid round shape, but is slightly bent. The vent hole is smooth and appears to have been cleaned recently. The unusual vent field is delineated by a raised moulding in the stylised shape of a mosque dome (Figure 47).

There is a large Arabic inscription (or *abjad*) etched across the top of the base ring:

Translated (from right to left), it reads “Sultan Government 1269”. There is no doubt that this cannon was a royal gun. Assuming that “1296” is a date, it is highly unlikely to represent A.D. 1296. Rather, it is the year 1296 of the Islamic calendar (*hijri*), corresponding to the year 1852. This inscription, then, dates the gun to the end of the reign of Sultan Omar Ali Saifuddin II (1828–1852), and makes it an important piece of Brunei history. During this period, Brunei was at war with the British and, to an extent, with Southeast Asian piracy. It is well documented that Brunei used European-style ordnance during the war (Mundy 1848:150; Pengiran Haji Osman 2007:71).

Forward of the vent are two reinforce bands and fillet, followed immediately by a large Oriental motif decoration. The trunnions attach to a short second reinforce, joined to the first reinforce and chase by astragal-and-fillets type reinforce bands.

Two more reinforcing bands are located near the neck, and the large funnel-shaped muzzle has a flat, circular face. In general, these features are Southeast Asian and suggest that the gun is a local copy of a European type—in a sense, a hybrid

Figure 47. Arabic inscription on the base ring of cannon 1974-66.

Figure 48. Spiral wear patter and crown pieces inside the bore of cannon 1974-66.

design. The gun's bore diameter (6 cm) and overall length (137 cm) make this cannon comparable to a European falconet (Mauncy 1965:34–35).

Inside the bore, a 'spiral' wear pattern and six encircling rings are clearly visible (Figure 48). The spiral grooves are a strong indication that the cannon was fired, while the rings are possibly crown pieces. Wear on the bore surface from firing and, to some degree perhaps, from corrosion has exposed the crown pieces to make them visible. Neither any of the rings nor the cannon itself reacted to the magnetic test. This cannon was probably cast from a copper alloy in the European style, following Wignall's (1973) interpretation, using copper alloy crown pieces to support the bore mould rather than chaplets.

Cannon 1967-X

Type: *bedil buloh* (HD)

Overall length: 144.0 cm

Category: 91–150 cm category

Bore diameter: 4.0 cm

Weight: N/A

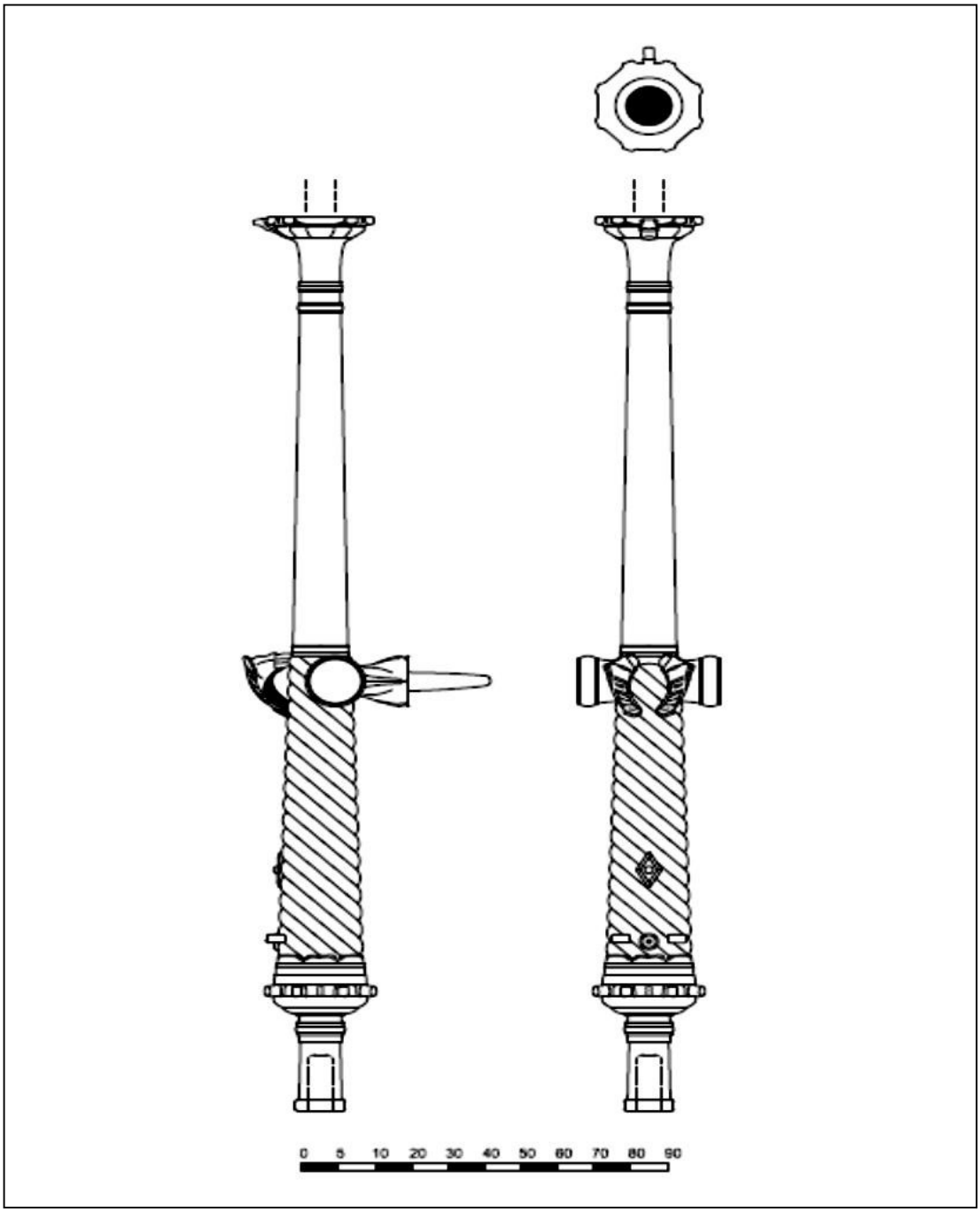


Figure 49. Drawing of cannon 1967-X.

Cannon 1967-X is a *bedil buloh* (HD) with a *gaganok* cascabel (Figure 49). The gun's breech reinforce is a *bunga matahari* type ring with eight protrusions. The vent is situated in a circular vent field between two perforated lugs, but its cover is missing. Forward of the vent is a lozenge motif (*madu kesirat*) surrounding a circular bulb that probably served as a sight.

The entire first reinforce is fashioned with a twisted rope motif called *ulas kalat*. Bantong Bin Antaran (1989:2) believes this design feature to be Malayan, but a similar design motif can also be seen on Indian made cannon in the armoury of the Tower of London (Figure 50).

Figure 50. Seventeenth-century Indian cannon (from Blackmore 1976:158).

The gun's trunnions are located at the very end of the reinforce, just below the centreline. On top of the reinforce, at the same longitudinal location, sit two dolphins with forward looking eyes and open mouths joined to the reinforce ring (Figures 51 and 52). Despite Gardner's (1936:93) claim that the dolphins are purely ornamental, they probably also served their practical function as lifting lugs (although the gun's weight is not known, it certainly would be difficult for a single person to carry).

As is typical, the cannon has two reinforce bands around its neck, and its muzzle is large and flat. However, like the breech reinforce, the muzzle is fashioned in the *bunga matahari* style. On top of the muzzle is a sight, which, though partially broken, is styled as a half-leaf motif (*daun setampik*). The bore is heavily degraded and obscured by concreted stones, making it impossible to detect any evidence of firing or manufacturing techniques.

There are two telltale signs on the cannon that indicate how the gun was made. Firstly, patched chaplet holes on the chase and line impressions from the location markers inscribed on the wax model before casting, and only visible now on the cannon body with the help of a magnifying glass, evince that the gun was cast using the lost-wax method. The chaplets used to hold the gun's bore mould were quite thin, rather than the more typical thick bars with circular or rectangular cross-section.

Figure 51. One of the soldered expansion joints on cannon 1967-X.

The second sign is two soldered cut lines on the reinforce ring that extends across the ogee and onto the chase (Figure 51). This testifies that the cannon's reinforce and chase were cast as separate pieces and then joined together. These 'expansion' cuts were made to facilitate the chase being fitted into the reinforce by mechanical joining (Oron 2001:22). This involved pushing the chase into the reinforce while rotating it back and forth, as indicated by the spiral wear marks on the forward edge of the ogee and the chase (Figure 52). Once the chase was fastened, the openings were closed

with solder. The reinforce band and dolphins served to further strengthen the joint.

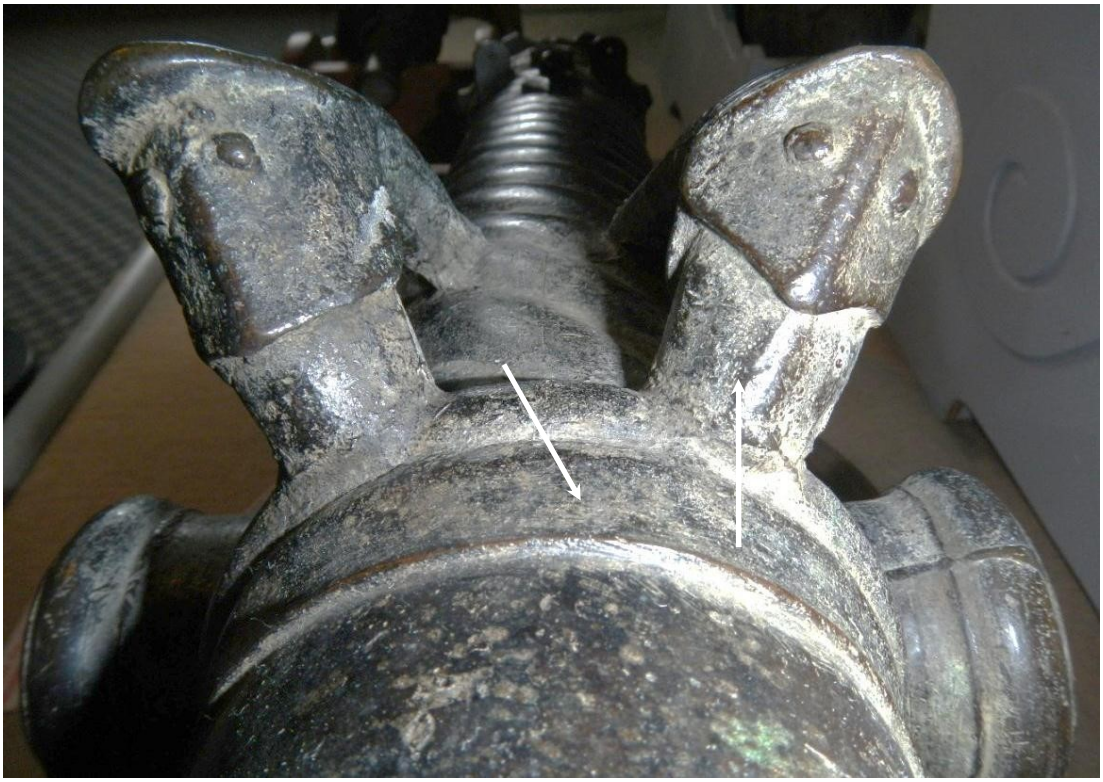


Figure 52. Spiral wear marks from fitting the chase into the reinforce of cannon 1967-X.

Figure 53. Traces of soldering on the left clasp.

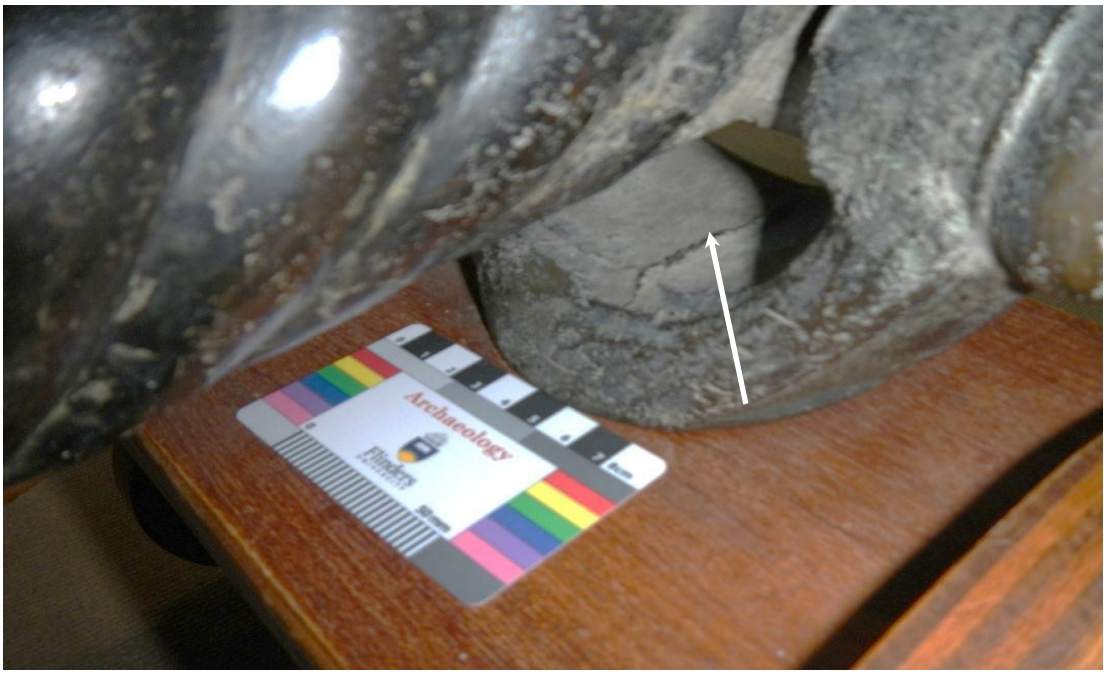


Figure 54. Traces of soldering on the base of the pin.

The yoke of the cannon is the clasped type. Soldered joints on the left socket and along the top of the base of the yoke (where the arms come together) reveal how the

yoke was fitted onto the cannon (Figures 54 and 55, respectively). The cannon maker first slipped the right socket onto the right trunnion, with the left socket opened slightly and the left arm of the yolk bent outward. He then slid the left socket onto the end of the left trunnion, the opening providing the necessary slack. By hammering (or otherwise forcing) the left socket onto the trunnion, the left yoke arm is bent inward until it returns to its symmetrical shape, and the socket fully encloses the left trunnion. All that is left for him then to permanently fix the yolk is to solder the now closed score line between the yolk arms and to close and solder the clasp.

Application of Proposed Method

Harrisson's ratio, the quotient of a cannon's bore diameter to its overall length, was calculated for each of the study cannon, except the *bedil gargabus*, Cannon 1966-840. That gun is of a different nature altogether, being a close-range anti-personnel weapon, and has a disproportionately large bore to suit that purpose. The cannon dimensions and resulting ratios are listed in Table 5. Similar to the cannon and corresponding Harrisson ratios presented in chapter 6, none of these cannon have a ratio greater than 4.5%. This only strengthens the possibility that Southeast Asian gun founders designed their guns to some type of standard proportion. Furthermore, it appears that conventional Southeast Asian cannon types have ratios of less than 4%, whereas those cannon not considered typical of Southeast Asian types, such as the two *meriam* cannon and Carronade Island Gun no.1, have ratios of greater than 4%. *Meriam* cannon may have been standardised with bore-to-length ratios of about 4%. However, since only three of the cannon for which the Harrisson ratio was calculated fall into this category, it is too early to draw any firm conclusions.

Table 5. Harrisson Ratios of the study cannon

Cannon	Bore Diameter H (cm)	Overall Length E (cm)	Harrisson Ratio H/E (%)
1966-219	3.4	124	2.7
1966-366 B	3.4	121	2.8
1969-36	6.0	137	4.4
1973-9	2.3	78	2.9
1974-66	6.0	137	4.4
1967-X	4.0	144.5	2.8

CHAPTER 9
CONCLUSION

The principal aim of this study of Brunei's Southeast Asian cannon was to illuminate how the guns were manufactured. Little is known of this, primarily because of the dearth of historical records, a hindrance evident in recent publications on Southeast Asian cannon. The best sources of information, then, are the few surviving archaeological gun-founding artefacts and the traditional gun-casting that continues to be practiced at the BAHTC. Through careful observation of these items and procedures, this study has shown that Southeast Asian cannon, at least in Brunei, were and are made by a form of lost-wax casting.

Two of the most revealing pieces of evidence that indicate this are chaplet marks, or patched chaplet holes, and position marker line impressions left on the outer surface of the cannon. Metal chaplets connected the inner bore mould to the outer model mould, thus transecting the wax model between. They were needed to keep the inner mould from 'floating' during casting, from when the molten metal is poured (and the wax model vaporised) until it has cooled and set sufficiently to support the mould itself. After the cannon was removed from the mould, the protruding chaplets were pulled out and the resulting hole filled with metal and patched, or the chaplets were cut away and sanded flush with the cannon surface.

When preparing a cannon mould, the gun maker etches guidelines into the wax model to locate where particular features are to be attached. Impressions of these marker lines are transferred to the clay mould and, subsequently, onto the cannon made in the mould. However, because of the sanding and polishing that the craftsman does to finish his cannon, these are often difficult to detect.

Casting errors also can be extremely informative with respect to manufacturing

methods. This was demonstrated in the distorted muzzle face of Cannon 1966-74 (*bedil buloh*) and the sprue marks and uneven surface on the muzzle face of Cannon 1966-366B (*bedil buloh* HD). Such evidence is, of course, subjective, but in combination with other clues can be quite revealing. This research was fruitful only because most of the cannon provided for study had imperfections or some degree of degradation. If made perfectly, any signs left from the casting process would be almost undetectable.

This study also revealed two variant types of cannon construction, one involving multiple lost-wax castings and another combining casting and forging. The reinforce and chase of cannon 1967-X (*bedil buloh* HD) were lost-wax cast using separate moulds and then joined together by manually inserting the aft end of the chase into the forward end of the reinforce and securing the join with a reinforce band, ogee, and dolphins. Cannon 1966-366B was made in a composite manner. First, the barrel was lost-wax cast as a single piece. The reinforce then was built up and strengthened by forging strips of bronze sheeting onto the cannon.

This research does have its shortcomings, as it only managed to identify the build method for four of the seven subject cannon. This is mainly because the other three cannon examined more or less do not bear any resemblance to the information that had been gathered. Firstly, Cannon 1966-840 (*bedil gargabus*) likely was manufactured by lost-wax casting, but the study failed to provide any concrete evidence to support this presumption. No determination was reached on the manufacture of Cannon 1969-36 (*meriam*), although its design is similar to a known Bruneian-made cannon, and so it too likely has alocal origin. Conversely, cannon 1974-6 (*meriam*) is likely to be the product of European-style gun casting methods, based on the observation of crown pieces inside the bore and the gun's similarities to

standard European Saker type cannon. These exceptions, however, provide valuable insights to early Bruneian gun founders, demonstrating that they were open to foreign influences and incorporated various techniques into their gun making tradition. They certainly were capable of other methods of gun making than just conventional lost-wax casting.

Another basic, but important point of inquiry for this thesis was to gauge how similar the 'traditional' gun casting practiced by the BAHTC today is to that of the past. From the evidence available to this study, the acclaimed gun casting of the BAHTC appears, quite convincingly, to be true to the historical tradition.

Examination of the sixteenth-century gun-founding artefacts—clay cylinders with a central longitudinal hole and clay crucibles—finds perfect parallels in the BAHTC casting method. The raw materials employed by BAHTC casters are the same as those identified in the archaeological remains: fine clay, paddy husks, *damar* and sand. The clay bore mould that the craftsmen build on their wooden dowel mirrors the perforated clay cylinders found at Kota Batu and Terindak Island. And the clay crucibles are virtually identical to those used today by BAHTC casters. Not only do these positive comparisons support the authenticity of the BAHTC casting methods, they also back an earlier dating of the origins of these methods; the sixteenth rather than eighteenth century, as is currently held. And although they may not prove an absolute continuity, the simple hand tools—hammer, chisel, file and scrapper—and traditional foundry equipment—Malay bellows, furnace and sand pit—that BAHTC casters employ are certainly congruent with historical foundry work. This is not to ignore the exceptions, such as the use of electric drills and the absence of quartz in the present-day component mix. The drill is a convenience only and does not impact the underlying method in any substantive way, and sand used to

coat the bore mould before the wax coating is applied could easily account for the presence of quartz on the archaeological moulds. That being said, it would still be beneficial to study if and how quartz might be used in metal casting, and what this might reveal about historical methods in Southeast Asia.

Possible standardisation of cannon also was investigated in this study. This was to reveal any rules-of-thumb that early caster might have employed and what this might tell us about how they conceived and designed their gun. However, "generalizations of early gun are difficult, for it is not easy to find two 'mathematicians' of old days whose ordnance lists agree" (Mauncy 1965:34). For the current study, the so-called Harrisson ratio, the quotient of a cannon's bore diameter to its overall length, was calculated for cannon with published data and for six of the seven subject cannon of this thesis (cannon 1966-840 was excluded). At present, the results show that cannon from across the region consistently have ratios of less than 4.5%. What remains to be determined is what this says about Southeast Asian cannon; how, if at all, does this relate to gun performance; was this a conscious decision by the gun founders or is this correlation inherent in the types of cannon built and used in Southeast Asia; and, if intentional, what factors or influences determined this parameter. Furthermore if this design parameter was indeed intentional, it would show that gun founders from across Southeast Asia were interacting with one another. At this point, the available dataset is simply too small to say anything conclusively, but the results are tantalising in their implications. An expanded study incorporating many more cannon and additional types of cannon is needed for the next step in addressing these questions. Documenting all 721 cannon in the Brunei Museum collection would be an excellent start. For this thesis, however, the author could not carry out such work due to time and permit

constraints.

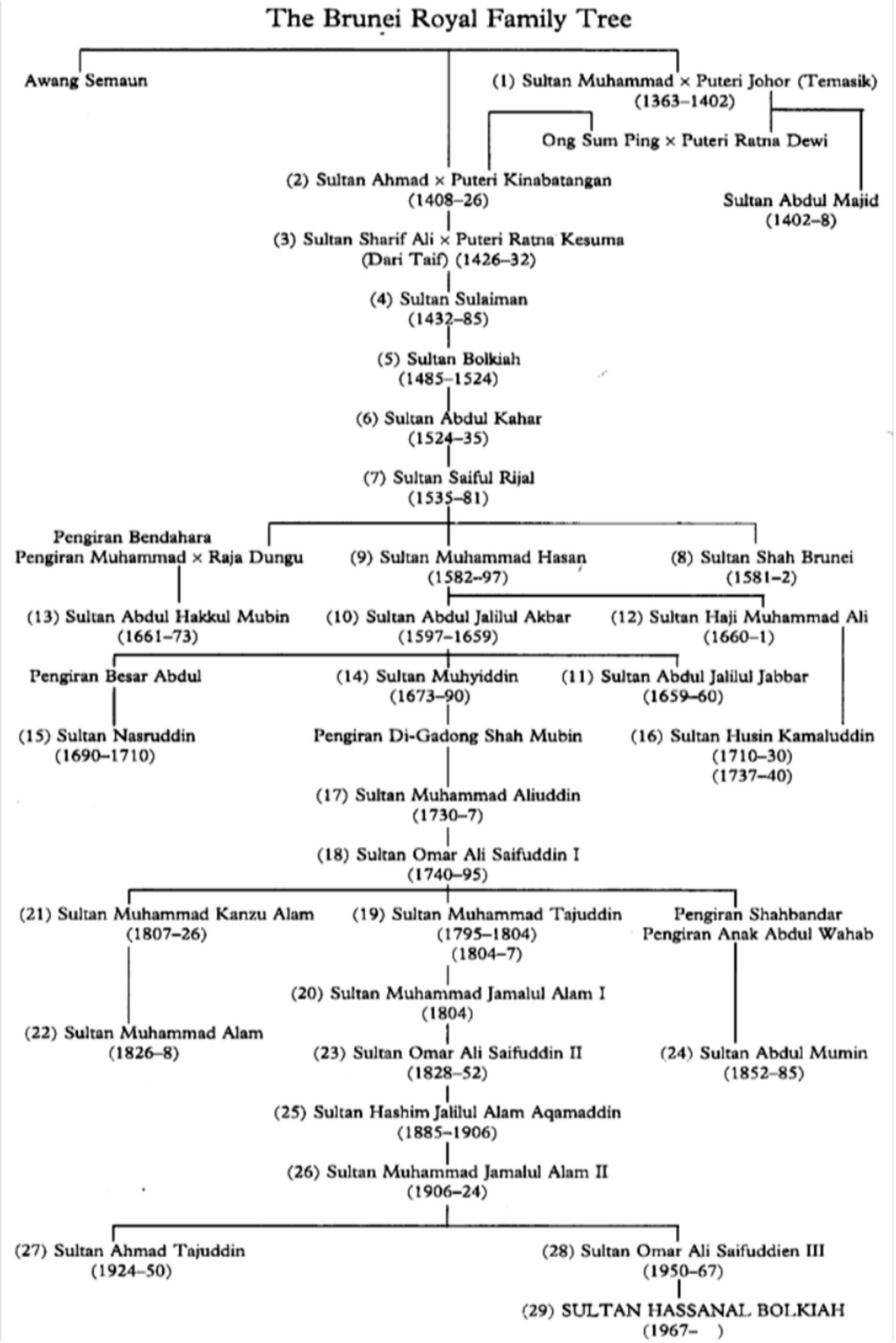
From an historical perspective, it remains to be shown how and from where cannon and cannon-making technology were first introduced to Southeast Asia, and Brunei in particular. Although local Bruneian authorities strongly believe that China was the primary source, evidence for other nation candidates is too strong to be easily dismissed. Potentially, detailed and extensive comparisons of cannon founding, design and decoration from different regions can bring to light possible influences and, conversely, the routes by which they travelled to the region.

Another subject sorely lacking study is Southeast Asian cannon metallurgy; specifically, the type(s) of alloys used to cast cannon. No cannon in the Brunei Museum collection has been scientifically analysed to determine its metal components. Due to permit restrictions, this thesis research had to rely on visual examination and simple magnetic response testing for qualitative observations about the metals used. Proper metallurgical testing with componential, trace elemental and lead isotope analyses could determine not only what metals and alloys Southeast Asian and Brunei gun makers employed, but possibly even where they sourced these materials. It might also provide additional knowledge of their casting technology, as well as new evidence of the source of the technology, or its influences.

In conclusion, refinements and revisions of this research should be expected as archaeological studies into Southeast Asian cannon expand across the region. As perhaps is typical, this thesis raises more questions than it answers. It certainly would come as no surprise if, in the not too distance future, other variations of Southeast Asian cannon and gun founding methods were discovered.

APPENDICES

Appendix 1
Brunei Sultan Genealogy (Saunders 2002:43)



Appendix 2
Underwater Archaeological Research Section
Cannon Data Sheet

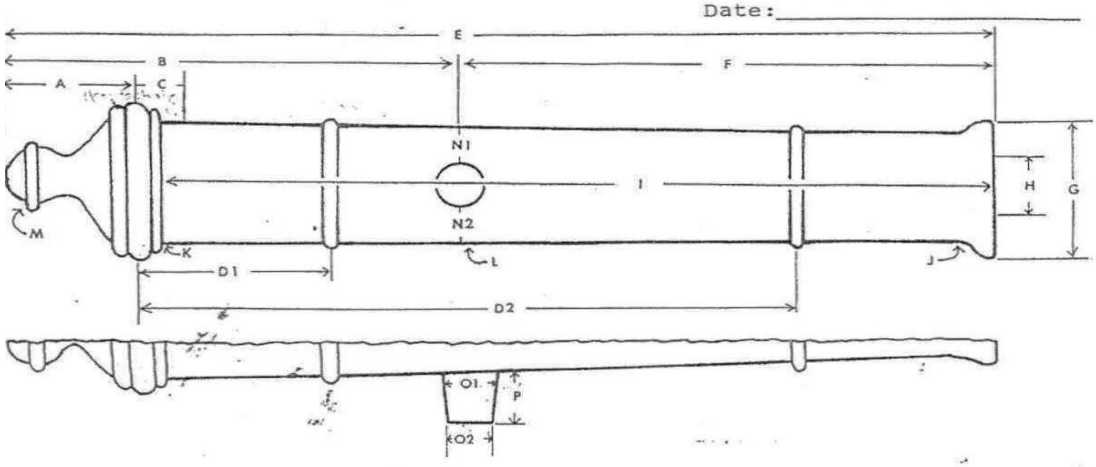
Underwater Archaeological Research Section

Site #:_____

CANNON DATA SHEET

Site name:_____

Date:_____



Site location and reference:_____

_____

_____

Location of cannon on site:_____

_____

Date cannon was located:_____

Divers:_____

_____

_____

Recorder:_____

_____

METRIC ATTRIBUTES

NOTE: Measurements requiring two readings for left and right sides should be taken viewing the cannon on the touchhole side (dorsal) from the cascabel down the tube.

A. Cascabel to breech reinforce _____

B. Cascabel to trunion _____

C. Reinforce to touchhole _____

D. Breech reinforce to each other reinforce band

	Distance	Thickness
1.	_____	_____
2.	_____	_____
3.	_____	_____
4.	_____	_____
5.	_____	_____
6.	_____	_____

write any additional reinforce measurements on back

E. Overall length _____

F. Trunion to muzzle length _____

G. Muzzle diameter _____

H. Bore diameter _____

I. Bore depth _____

J. Diameter behind muzzle flare _____

K. Diameter in front of breech reinforce _____

L. Diameter of tube at trunions _____

M. Diameter of cascabel _____

N. Vertical position of trunion on tube

1. trunion to dorsal _____

2. trunion to ventral _____

O. Diameter of trunion

1. at tube left_____ right_____

2. at ends left_____ right_____

P. Length of trunions left_____ right_____

Other:_____

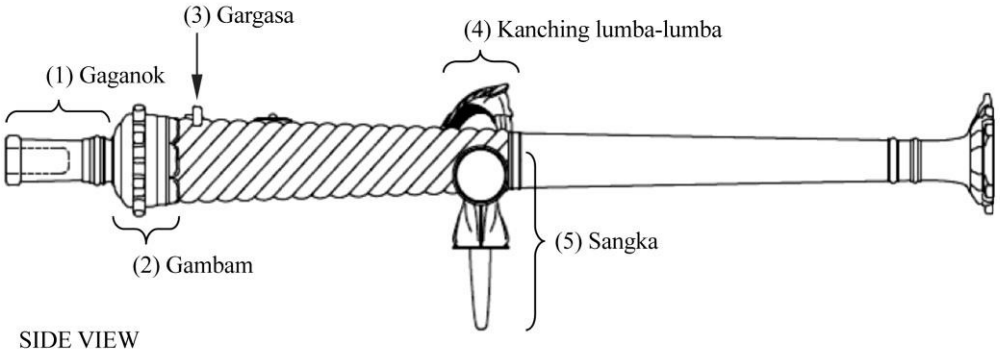
_____

NON-METRIC ATTRIBUTES

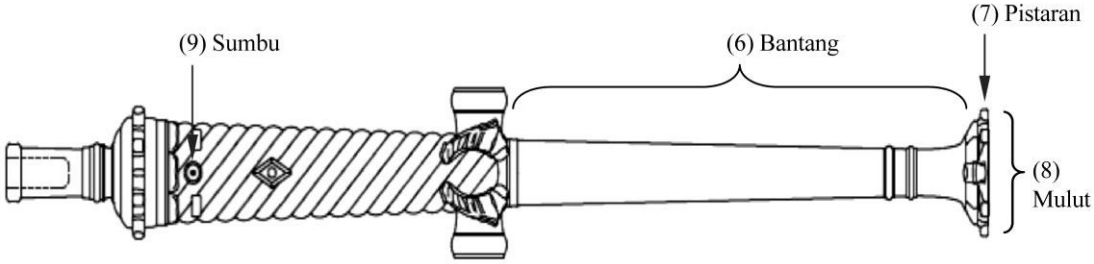
answer on reverse side

1. Depth to and description of bottom.
2. Type of sediment(s).
3. Lifting handles: description & necessary accompanying measurements.
4. Any other pertinent attributes: distinguishing marks, insignias, dates, color, condition, type of metal, etc.

Appendix 3
Cannon Terminology in Bruneian Malay and English



SIDE VIEW

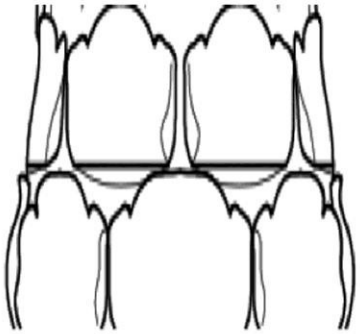


TOP VIEW

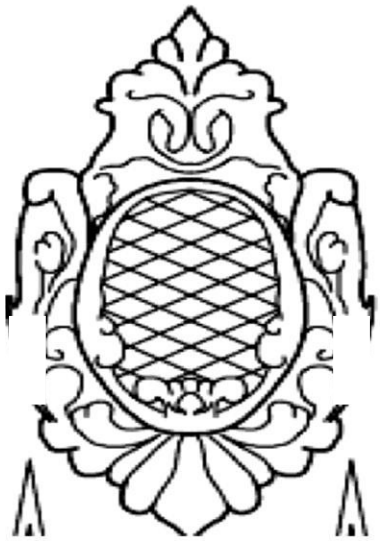
Malay (Brunei)	English
(1) gaganok	(1) tubular cascabel
(2) gambam	(2) breech/breech reinforce
(3) gargasa	(3) lug
(4) kanching lumba-lumba	(4) dolphin
(5) sangka	(5) yoke
(6) batang	(6) chase
(7) pistaran	(7) sight
(8) mulut	(8) muzzle
(9) sumbu	(9) touchhole/vent

Appendix 4
Motifs Terminology (Antaran 1989)

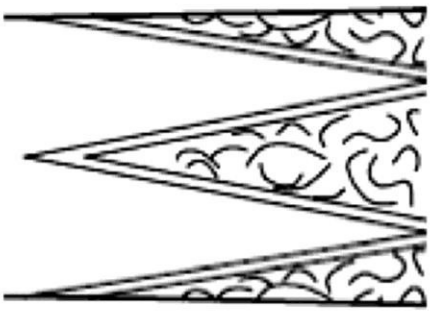
Pucuk Rebung and *Bunga Menjalar* 1966-219



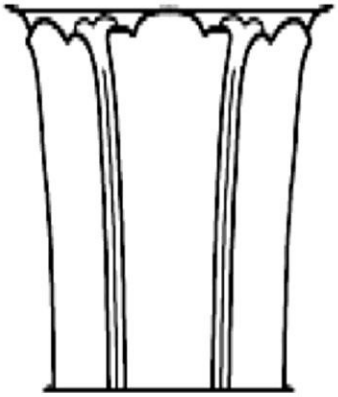
Sisik Penyu (Turtle Shell) 1966-219



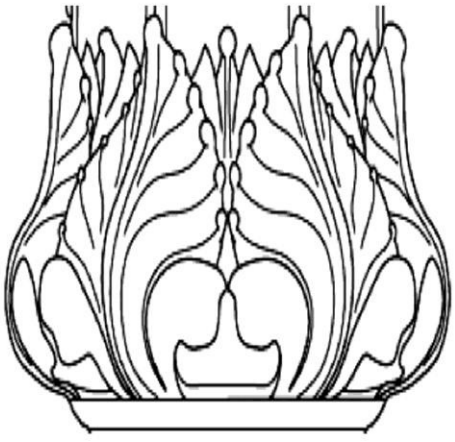
Daun Suganda with *sisik penyu* in the middle 1966-219



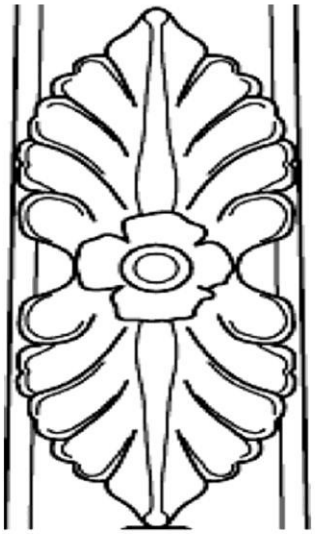
Pucuk Rebung and *Bunga Menjalar* 1966-219



Jari Satak 1966-840

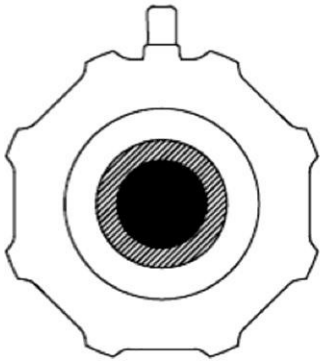


Daun Lukut at breech reinforce 1966-840

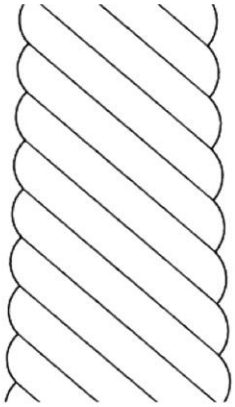


Daun Lukut 1966-840

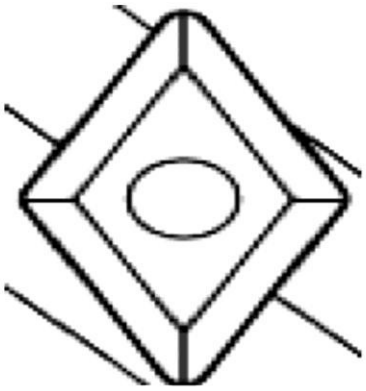
Daun Setampik 1967-X



Bunga Matahari 1967-X



Ulas Kalat 1967-X



Madu Kesirat 1967-X

Kupu-Kupu 1969-36